INSTRUCTIONAL UNITS IN HAND WOODWORK

BROWN AND TUSTISON

Instructional Units In Hand Woodwork

Digitized by the Internet Archive
in 2023

https://archive.org/details/bwb_G5-AZV-850

Instructional Units In Hand Woodwork

F. E. Tustison, M.S.

Department of Science and Home Mechanics, The Stout Institute, Menomonie, Wisconsin

AND

Arthur G. Brown, Ph.D.

Department of Education, Formerly Instructor of Woodwork and Wood Finishing, The Stout Institute, Menomonie, Wisconsin

PROPERTY OF
SCHOOL CITY OF SOUTH BEND
WASHINGTON SCHOOL

THE BRUCE PUBLISHING COMPANY
MILWAUKEE, WISCONSIN

Copyright, 1930

The Bruce Publishing Company
Printed in the United States of America
(Eleventh Printing — 1949)

FOREWORD

If the teacher asks himself, "What is the scope of my work?" he is sometimes surprised when he gets the real answer. He must analyze, he must select, and he must teach. His work in analysis must include pupils, both "as is" and "as to be." It must include content, in both its contributions to the individual's performance now and later, and its contributions to his development in ability to interpret the life situations in which he finds himself. His work in selection must be on a basis broad enough to take advantage of this breadth of analysis. In other words, the teacher's selections must be the best for the pupil and the best for society. The teaching must carry method and emphasis to bring about pupil acquisitions in the range and depth included in this selection.

If the content has its origin in a modern occupation or group of occupations, the scope of the analysis mentioned in the foregoing will include the following phases: locations in modern establishments or situations, kinds of workers, kinds of work (constructions, products, installations, etc.), units of work, and basic things done. The selected portions for school instruction will be arranged in a learning order. The new basic things will be identified. The related material will be indicated. This indication will include sources of material both on projects and on operations or processes. It will be technical and occupational.

With the source content analyzed, the teacher must analyze his pupils. These may be exploratory, semispecialization, specialization, general education, or extension. With the pupil purpose-classification, the ability grouping, and the progress record, the teacher makes his selection. As the pupil progresses, he participates in this selection.

This book identifies the "basic things done" in the handwork portion of woodworking. Progress records of pupils should indicate the "basic things done" which have been covered and the combinations in which they have been involved. For instance, the exploratory pupil should participate in a representative sampling of basic operations or processes. These "basic things done" should be involved in work which is typical of a good representation of the occupational work as found in the various kinds of establishments, in the distributions of the kinds of workers, in the kinds of constructions, products, or installations, and in the units of work. The chart included in this publication may be used directly. In the checking spaces adjacent to the processes, three groups of uses are possible. Numbers may be used as checking

entries to indicate the processes involved in a given project in the order in which they are involved. Second, check marks may be used instead of numbers, the pupil being required to indicate by number the order in which the processes are involved in the project. Third, no entries are put in at all, the pupil being required to select the processes and indicate their sequence.

The form in which the material in this book is presented makes it immediately available for the teacher of woodwork in the complete range of possible situations, both from the pupil-classification standpoint and from the content-classification standpoint. With an accurate analysis of the pupil purposes and abilities, this instructional material is in an immediately accessible form for instructional use in the total range of situations from the simple project of the exploratory student to the rather sharply focused assignment of the extension student. The progress being made in pupil classification as to "purpose" and "ability" groupings is bringing out the fact that many shop classes are mixed groups when analyzed for the planning of instruction. To meet the various instructional pupil groupings, the modern teacher of industrial work in wood will find this material a continuous aid, arranged as it is, ready for many combinations of work and pupils.

Clyde A. Bowman,
Dean, School of Industrial Education,
The Stout Institute, Menomonie, Wis.

INTRODUCTION

Hand Woodwork is the oldest and has been one of the most popular courses in recent public-school industrial arts. Although the introduction of metal work, electricity, and the like have reduced its popularity somewhat, it is believed that woodwork will and should be included in every industrial-arts curriculum. The values received in a well-organized course in hand woodwork rank high in light of the accepted objectives for the education of the adolescent boy. Such a course develops a maximum amount of handy-man abilities, supplies a sufficient amount of general information, and affords training of vocational value for those who will enter industry.

The need has been felt for instructional material covering the basic-unit operations in the field of woodwork. Heretofore, most analyses have been made in terms of tools. The authors feel that the analysis should be made in terms of things done or operations performed, rather than in terms of tools. Tools are used only to accomplish what the workman desires to do.

The need has been felt not only for instructional units on the common woodworking operations, but also for a clearer method of presentation. The authors have attempted to prepare a text with these needs in mind. A complete analysis of each unit operation has been made, and each step in the procedure has been set out clearly and distinctly. Definite instructions have been included to aid in the performance of each step. The directions have been made as brief and concise as possible. Where the method of doing has been difficult to describe clearly in words, illustrations have been added. Numerous photographs, drawings, and sketches, with explanatory legends have been included to add life to the instructions. These arouse interest as well as aid materially in performing the operation. A complete list of questions follows each unit. The questions cover all the important items in the instructions. Such questions will aid the pupil in selecting the important information he is expected to learn in order to successfully perform the operations. The questions will also be of value to the teacher in a thorough testing program.

These instruction units are intended for use as a text in any course in hand-tool woodwork. The directions for performing the operations are not restricted to any local course of study. It is apparent that any one set of exercises, jobs, or projects is not appropriate in all situations. Therefore, the aim of the authors has been to develop instructional

material that is general in nature and that will apply to any job or project. Such a text should then be useful in any course where the fundamental operations of hand woodwork are to be taught. It is therefore adaptable for use in the junior high school, senior high school, vocational school, part-time school, evening school, college, or teacher-training institution.

Some suggestions concerning the use of the text may be of value to the teacher. The attempt has been made to arrange the units in

ANALYSIS CHART

(Check to indicate the operations in projects)

UNIT OPERATIONS	PROJECTS: Jewel Box	Tool Box	Mortise Box	Utility Box	Bird House	Bookrack	Cabinet	Medicine Cabinet	Flower Box Bracket	Book Shelf	Bookshelf Table			
1. Get out rough stock (routing order)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
2. Read a working drawing	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
3. Make out complete bill of material	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
4. Measure	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
5. Lay out lines with squares or T bevel	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
6.A Gauge with marking gauge		✓	✓				✓	✓	✓	✓	✓	✓		
6.B Pencil gauge			✓					✓				✓		
6.C Gauge with rule and pencil	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
7.A Saw to straight lines with crosscut saw	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
7.B Saw to straight lines with backsaw							✓	✓	✓	✓	✓	✓		
7.C Saw to straight lines with ripsaw	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
8. Fit a handsaw														
9. Square up stock (routing order)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
10. Assemble and adjust a plane	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
11. Grind a plane iron							✓	✓	✓	✓	✓	✓		
12. Whet a plane iron, chisel, etc.			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
13. Plane a surface (a face)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
14. Plane (joint or bevel) an edge	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓		
15. Plane end grain			✓		✓	✓	✓	✓	✓	✓	✓	✓		
16. Plane a through chamfer			✓				✓		✓					
17.A Scrape surface with cabinet scraper				✓			✓	✓			✓	✓		
17.B Scrape surface with hand scraper							✓	✓			✓	✓		
18. Sand unfinished surface	✓	✓	✓	✓			✓	✓			✓	✓		
19.A Lay out a design with pattern					✓							✓		
19.B Lay out a regular hexagon														
19.C Lay out a regular octagon							✓							
19.D Lay out a rounded corner	✓					✓								
19.E Lay out an ellipse				✓										
19.F Lay out irregular curves		✓						✓		✓		✓		
20.A Saw curves with coping saw								✓		✓		✓		
20.B Saw curves with turning saw				✓										
20.C Saw curves with compass saw								✓				✓		
21.A Pare curved surfaces with chisel	✓					✓								
21.B Pare with drawing knife									✓					
21.C Shape curves with spokeshave				✓				✓				✓		
21.D Pare curves with gouge		✓												
21.E Shape curves with cabinet file or rasp				✓				✓		✓		✓		
22. Bore with brace and auger bits	✓			✓	✓	✓		✓	✓	✓	✓	✓		
23. Bore with twist drills or drill points					✓	✓	✓	✓			✓	✓		
24.A Clamp stock with bar clamps								✓			✓	✓		
24.B Clamp stock with hand screws												✓		
24.C Clamp stock with screw or C clamps												✓		
25.A Mix and apply hot animal glue							✓				✓	✓		
25.B Mix and apply casein glue														
26.A Glue up stock edge to edge							✓					✓		
26.B Glue up stock face to face												✓		
27. Fasten butt joint with nails				✓	✓			✓	✓	✓		✓		
28. Fasten joint with screws				✓	✓	✓	✓			✓	✓	✓		
29. Fasten butt joint with dowels											✓			
30. Make and fasten a miter joint									✓	✓		✓		
31. Fasten joint with plates or braces										✓		✓		
32. Make and fasten a half-lap joint							✓	✓						
33. Make a rabbet-and-butt joint								✓				✓		
34. Make a dado-and-butt joint						✓		✓				✓		
35. Make a rabbet-and-dado joint									✓			✓		
36. Gain for a joint										✓		✓		
37.A Make a blind mortise-and-tenon joint											✓	✓		
37.B Make other mortise-and-tenon joints														
38. Hang a door or attach a cover										✓				
39. Attach a cabinet lock										✓		✓		

the order of performance as followed in the construction of the typical project. Units, such as the fitting of a handsaw, which are rarely performed, have been placed in the sequence according to content rather than performance. However, in actual use the order of instruction will vary according to the particular job.

After the aims and objectives have been set up, a course is organized to attain the aims or objectives desired. Projects are selected as indicated in Unit 1.

Books of projects, drawings, and current magazines will aid in the selection. The selected project is then analyzed by the teacher and pupil to determine the unit operations involved. The graphic analysis chart on page viii will be found useful in checking the operations to be performed in each project. This chart illustrates the analyses of several typical projects. For example, the initial project for any pupil might well be a swing board, a sand block, a mounting board, or a cutting board. In each instance the checks indicate the operations involved and therefore the instructions needed. If desirable, the operations may be numbered in the order of performance. The chart will then serve as a job plan or routing order. Assignments are then made to the units describing these operations. These units are then studied and discussed in the order of performance. Demonstrations should be given to aid the pupil in mastering difficult new operations. Each succeeding project is analyzed in a similar manner. A glance at the chart discloses old operations repeated and new operations involved. Such information is extremely valuable to the teacher in organizing a course of study. It will aid in the control of the selection of new projects, and in the grading of the projects with reference to the new operations to be performed. New operations, as shown by the checks on the chart, are assigned and studied in the order of their occurrence. The chart of a complete course should serve as a valuable record of pupil achievement. It is especially useful in checking individual accomplishment where all pupils do not make the same projects.

Acknowledgment is made by the authors of the constructive suggestions offered by many of their colleagues at The Stout Institute. Special acknowledgment is due R. L. Welch, Dean C. A. Bowman, and R. A. McGee (former colleague and co-author) for direct assistance in the preparation of the text. Many drawings and sketches were prepared by Edwin M. Reed.

Acknowledgment is due to the following companies who generously furnished information used in the text: The Stanley Rule and Level Company; Henry Disston and Sons, Inc., and The American Glue Company.

F. E. Tustison
Arthur G. Brown

SUGGESTED RELATED INFORMATION

A recent unpublished study by the authors discloses a tendency to increase the related informational content in industrial-arts courses. In this text, space does not allow the inclusion of the wealth of related information that might be used to advantage in a course in woodwork. It is believed that definite time should be set aside for study and discussion of related topics. The United States Department of Agriculture and manufacturers of woodworking tools and supplies furnish many valuable pamphlets and bulletins to schools free of charge. In some cases, a small charge is made for the larger government bulletins, some of which were prepared especially for this purpose. *The Forest,* a handbook for teachers, is a splendid single reference outline for the teacher. A shop library can be provided at very little cost. Following is a suggested list of related informational topics and available reference material. Each teacher should make provision for this or similar instruction. The list is only suggestive, and no importance is attached to the order of sequence.

1. *Selection of Projects:*

The selection of projects is an important consideration in the organization of a course. The selection should be based on the needs and interests of the pupils in a particular situation. A great many excellent books of projects have been put on the market by various publishers. New designs and drawings of projects are frequently being made available. In order to keep abreast of the new developments and new thought in industrial-arts education, it is necessary to examine the new books and to read the periodicals devoted to the stimulation and advancement of the subject. Publishers will gladly furnish copies of project books for examination, so that appropriate selections for particular situations may be made.

Several magazines on industrial arts should be a part of every shop library.

2. *Homes for Birds;* U. S. Dept. of Agriculture, Farmers' Bulletin No. 1456; *Boy Bird House Architecture,* Baxter, The Bruce Publishing Co., Milwaukee, Wis.
3. The Growth and Structure of Wood.
4. Junior Forests.
5. Wood and Its Uses.
6. Forests and Waters.
7. Enemies of the Forest.
8. The Service of the Forest.
9. The Friends of Trees and Forests.
10. Forests in History and Civics.
11. Forests and Geography.
12. Forests and Industry.
13. Wood for the Nation; Other Forest Products.
14. From the Forest to the Mill.
15. When Wood is not Wood.
16. Forests Near Home.
17. State and National Forests.

18. Forestry in America.

(For topics 3 to 18, see *The Forest,* a handbook for teachers, U. S. Dept. of Agriculture, Miscellaneous Circular No. 98.)

19. *America and the World's Woodpile;* U. S. Dept. of Agriculture, Circular No. 21.

20. *Wood for the Nation;* U. S. Dept. of Agriculture, Separate No. 835.

21. *A Mountain Vacation Land;* The Washington National Forest, U. S. Dept. of Agriculture.

22. *In the Open;* The National Forests of Washington, U. S. Dept. of Agriculture, Dept. Circular No. 138.

23. *Forest Fire Prevention;* Handbook for the Schools of Oregon, U. S. Dept. of Agriculture, Miscellaneous Circular No. 20; Handbook for School Children, U. S. Dept. of Agriculture, Miscellaneous Circular No. 79.

24. *Pulpwood for Paper;* How the United States Can Meet Its Present and Future Pulpwood Requirements, U. S. Dept. of Agriculture, Dept. Bulletin No. 1241.

25. *The Identification of Furniture Woods;* U. S. Dept. of Agriculture, Miscellaneous Circular No. 66.

26. *What is Meant by "Quarter-Sawed";* Forest Products Research in Pictures No. 60, Forest Products Laboratory, Madison, Wis.

27. *Forests and Floods;* U. S. Dept. of Agriculture, Circular No. 19.

28. *Home Woodlands;* U. S. Dept. of Agriculture, Dept. Bulletin No. 863.

29. *Tree Planting;* U. S. Dept. of Agriculture, Farmers' Bulletin No. 1312.

30. *Reforestation on the National Forests;* U. S. Dept. of Agriculture, Dept. Bulletin No. 475.

31. *Street Trees;* U. S. Dept. of Agriculture, Dept. Bulletin No. 816.

32. *The Windbreak;* U. S. Dept. of Agriculture, Farmers' Bulletin No. 1405.

33. *Government Forest Work;* U. S. Dept. of Agriculture, Dept. Circular No. 211.

34. *Forest Products;* U. S. Dept. of Agriculture, Dept. Circular No. 231.

35. *Timber Shortage;* U. S. Dept. of Agriculture, Dept. Circular No. 112.

36. *How Lumber is Graded;* U. S. Dept. of Agriculture, Dept. Circular No. 64.

37. *Veneered and Solid Furniture;* Technical Note No. 197, Forest Products Laboratory, Madison, Wis.

38. *Manufacture of Glue;* Animal Glues, Their Manufacture, Testing and Preparation; Casein Glues, Their Manufacture, Testing and Preparation; Glues for Use with Wood—Technical Note No. 207; Forest Products Laboratory, Madison, Wis.; The Glue Manual, Henry Wilhelm Company, Pittsburgh, Pa.

39. *Historical Use of Glue;* Glue Problems, Monite Waterproof Glue Co., Minneapolis, Minn.

40. *Strength of Commercial Liquid Glues;* Technical Note No. F–2, Forest Products Laboratory, Madison, Wis.

41. *The Making of Steel and Wire;* Catalog, American Steel and Wire Co., Chicago, Ill.

42. *Different Types of Nails and the Penny System;* Manual of Carpentry, American Steel and Wire Co., Chicago, Ill.

43. *The Common Screws;* Catalog, American Screw Co., Providence, R. I.

TABLE OF CONTENTS

		PAGE
	Foreword	v
	Introduction	vii
	Suggested Related Information	x
UNIT		
1.	To Get Out Rough Stock for a Project — Routing Order	1
2.	To Read a Working Drawing	4
3.	To Make Out a Complete Bill of Material	10
4.	To Measure (Using the Common Woodworking Rules)	17
5.	To Lay Out Lines (Using the Woodworker's Squares)	23
6.	Methods Used for Gauging	29
7.	To Saw to Straight Lines	33
8.	To Fit a Handsaw	40
9.	To Square Up Stock — Routing Order	50
10.	To Assemble and Adjust a Plane	52
11.	To Grind a Plane Iron	56
12.	To Whet a Plane Iron, Chisel, etc.	61
13.	To Plane a Surface	66
14.	To Plane (Joint) an Edge	71
15.	To Plane End Grain	76
16.	To Plane a Through Chamfer	80
17.	To Scrape a Surface	84
18.	To Sand an Unfinished Surface	91
19.	To Lay Out Various Figures and Designs	97
20.	To Saw Curves	103
21.	To Shape Curved Surfaces	108
22.	To Bore with Brace and Auger Bits	117
23.	To Bore with Twist Drills or Drill Points	123
24.	To Clamp Stock	127
25.	To Mix and Apply the Common Glues	135
26.	To Glue Up Stock	142
27.	To Fasten a Butt Joint with Nails	148
28.	To Fasten a Joint with Screws	156
29.	To Fasten a Butt Joint with Dowels	162
30.	To Make and Fasten a Miter Joint	167
31.	To Strengthen or Fasten a Joint with Plates or Braces	173
32.	To Make and Fasten a Half-Lap Joint	176
33.	To Make a Rabbet-and-Butt Joint	182
34.	To Make a Dado-and-Butt Joint	188
35.	To Make a Rabbet-and-Dado Joint	193
36.	To Gain for a Joint	196
37.	To Make a Mortise-and-Tenon Joint	201
38.	To Hang a Door	210
39.	To Attach a Cabinet Lock	215
	Index	219

Instructional Units In Hand Woodwork

UNIT 1

TO GET OUT ROUGH STOCK FOR A PROJECT ROUTING ORDER

The first thing that a pupil in a course in woodwork should do is to select a project. Such projects should meet a necessity or demand, thus making them practical. The first project made should be simple in design and construction, and if possible, composed of just a single part. It is often advisable for the instructor to select the beginning jobs in order to introduce the fundamental units of instruction at the proper time. The project selected should be one which will furnish the desired training and at the same time interest the boy. Figure 1 shows a typical woodworking project.

The successful workman saves time and material by the use of working drawings. Figure 2 shows a working drawing of the bird house in Figure 1. Drawings of projects similar to the one to be made should be carefully studied, and the most suitable one selected. If no suitable drawing is found, it is advisable to make one. A sketch will often answer the purpose. Any information about sizes, construction, and design, which can be obtained from similar drawings, should be used. Often slight changes in the design or dimensions of a project will increase its usefulness for a particular purpose. This offers an opportunity to exercise originality. After a drawing or sketch has been selected, it should be O.K.'d by the instructor before proceeding. Should the instructor select the project, he will undoubtedly furnish a working drawing.

Fig. 1. A wren house

When the pupil has decided what to make and a drawing is available, he should determine the sizes of the separate parts and figure the amount of lumber necessary to make the project. The next step toward making a project is to get out the rough stock for the different parts. "Getting out the rough stock" means to cut the lumber into pieces that will make each separate part. Since these pieces are just *roughly* cut, they are made slightly larger than the dimensions of the finished parts. (See Unit 3, step 4, for the oversize allowance.) This will allow each piece to be reduced later to accurate dimensions.*

**Note:* It is sometimes impractical for each boy to get out his own rough stock. It may be desirable for the rough stock to be cut on a power saw, or to have some boy or boys get out the stock for the class. In these cases, in order that all may profit from the experience, the job should be rotated among the different members of the class.

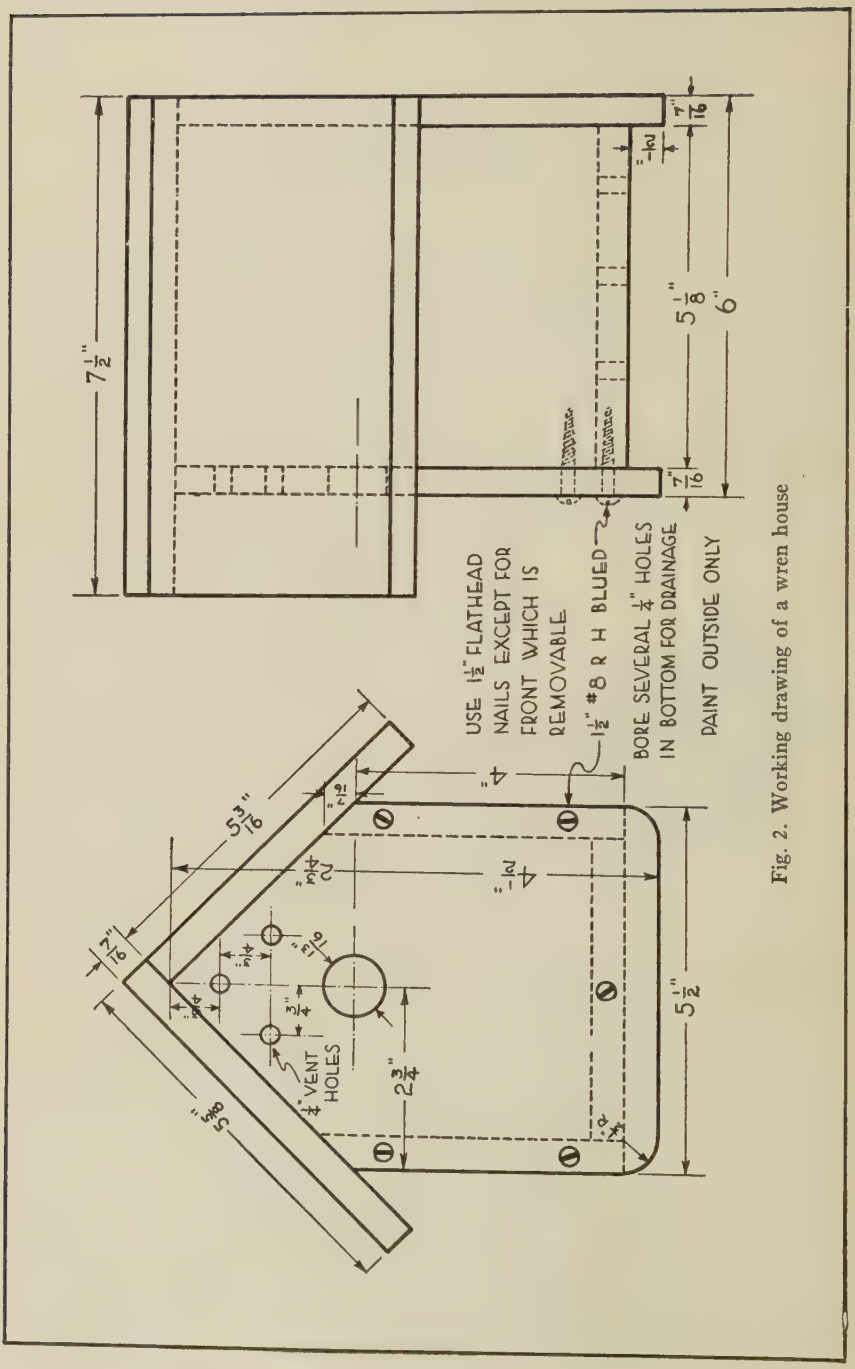


Fig. 2. Working drawing of a wren house

A number of operations are involved in getting out the rough stock, and it is well to give the beginner an opportunity to secure practice in performing them. *Reading a drawing, making out a bill of material, measuring, squaring, gauging,* and *sawing* are necessary in getting out the rough stock for any project. The job is comparatively simple for small projects containing only a few parts. When the project has a number of parts of different thicknesses, widths, and lengths, the job is quite complicated and a definite procedure can be followed to advantage.

Since so many operations are involved in getting out the rough stock, this unit is in reality a routing order or "job plan." The operations, as listed below, are in the order in which they are performed. The detailed directions for performing these different operations are given in Units 2, 3, 4, 5, 6, and 7. This unit, or routing order, when used in connection with the units to which reference is made, gives the worker all the information necessary for completing the first major step in the construction of a project.

Tools: Rule; framing square; try-square; pencil; crosscut saw; ripsaw.

Materials: Drawing of the project; necessary stock.

PROCEDURE:

1. **Select a project.**
2. **Select a drawing.**
3. **Read the drawing.** (Unit 2.)
4. **Make out the bill of material.** (Unit 3.)
   - *a*) Finished-stock list.
   - *b*) Rough-stock list.
   - *c*) Lumber bill.
   - *d*) Complete bill of material.
5. **Lay out the pieces.**
   - *a*) Measure. (Unit 4.)
   - *b*) Square. (Unit 5.)
   - *c*) Gauge. (Unit 6.)
6. **Rip and crosscut the pieces.** (Unit 7.)

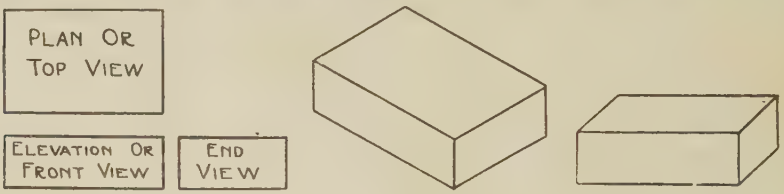
QUESTIONS:

1. Why should practical projects be selected?
2. What kind of project is best for the beginner to select?
3. What are the advantages in the use of working drawings?
4. When would you consider making changes in the design of a project?
5. What is meant by "getting out the rough stock"?
6. In "getting out the rough stock," why are the pieces made slightly oversize?
7. Name the operations usually involved in "getting out the rough stock."

UNIT 2

TO READ A WORKING DRAWING

A working drawing is a dimensioned drawing or sketch which contains all the information necessary for the construction of a project. For the consumer, it contains valuable information so often necessary in the selection of industrial products. In the school as well as in practical life, many situations arise where it is desirable to be able to read a working drawing. The situations calling for ability to read drawings far outnumber those calling for ability to make them. Especially in most industrial-arts activities in the school, the pupil is called upon to read sketches, drawings, or blue prints soon after he



A, Orthographic projection

B, Isometric

C, Oblique (cabinet)

Fig. 3. A rectangular block represented by three different kinds of drawings

begins the work. The ability to read drawings is a valuable asset, and because of its special application in a course in woodworking, it is introduced at this time.

Material: Working drawings.

PROCEDURE:

1. Note the Different Kinds of Dimensioned Drawings

Orthographic Projection. In orthographic projection, the object usually is represented by at least two distinct views and sometimes by three or more. The views most commonly drawn are the top, front, and right end. From the views shown, the workman must be able to secure complete information for the construction of the object. Figure 3, A, shows an orthographic projection of three views of a rectangular block. The basis of practically all working drawings has been orthographic projection. However, in orthographic projection it is often difficult for the untrained person to visualize the project, noting the exact relation of parts and the details of construction.

Pictorial Drawing. A pictorial shop drawing is a single drawing representing the object with three visible surfaces. In contrast with an orthographic-projection drawing, it gives a better pictorial representation of the object. It enables the pupil easily to visualize the object, and shows the relation of parts to each other. Such a drawing may be dimensioned in a fairly satisfactory manner. For the foregoing reasons the use of pictorial drawings has increased. The types commonly used are the *isometric* and *oblique.* The isometric shows three faces all inclined at an angle with the plane of the paper, as shown in B, Figure 3. Oblique drawings also show three faces, one of which is parallel to the plane of the paper. The cavalier oblique shows all measurements full size. The cabinet oblique derived its name from its common use in woodwork, and in order to present a better picture of the object the receding lines are shortened, as shown in C, Figure 3.

2. Note the Alphabet of Lines and Methods of Dimensioning (See Figs. 4 and 5)

The *solid* line represents the visible outline of the object.

The *dotted* or *short-dash* line represents the invisible outline.

Center lines usually are alternate long and short dashes. Sometimes they are drawn solid but always very fine. They often extend beyond the bounds of the drawing and are used to locate centers. Round holes are usually located by two center lines intersecting at the center of the hole.

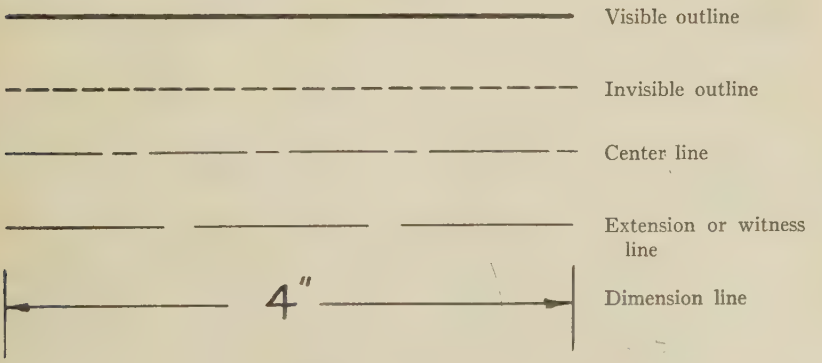


Fig. 4. Alphabet of lines used in drawings

Extension or *witness* lines are fine, long-dash lines extending from the outline of the figure to indicate the limits of the dimension line. They do not touch the outline. Sometimes they are used to connect the different views in orthographic projection, but the tendency is to omit them for this purpose.

Dimension lines are fine, solid lines terminated by arrowheads, used to indicate distances between points and lines. They are often broken

in the center for the insertion of the figures stating the dimensions from tip to tip of the arrows. Sometimes the figures are placed above the dimension line. A common error in reading dimensions is a failure to note where the tips of the arrows terminate. The dimensions are given in inches, feet, or a combination of the two. There is a tendency to give dimensions under six feet in inches. The following table illustrates the common methods of indicating dimensions:

15 in. — Fifteen inches	3′ – 0″ — Three feet
15 — Fifteen inches	2′ – 4″ — Two feet four inches
15″ — Fifteen inches	4′ – 2″ — Four feet two inches

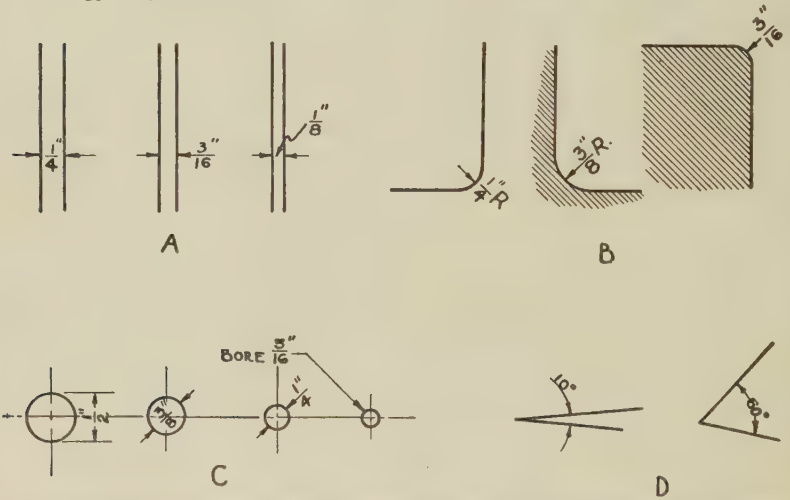


Fig. 5. Methods of dimensioning: A, limited spaces; B, arcs; C, circles; D, angles

Where the space is too crowded to indicate the dimension in the regular manner, the methods shown in A, Figure 5, are used. *Arcs* are dimensioned as in B, Figure 5. The figures represent the length of the radius of the arc in inches. The R (radius) may be given or omitted. *Circles* are dimensioned as in C, Figure 5. The figures given represent the diameter. *Angles* are indicated in degrees, as in D, Figure 5. Leaders usually are arrowed lines of no particular shape or position, and are used to call special attention to a dimension or part of the object. Figure 6 shows the general use of leaders.

3. Note and Check the Readings Taken from the Drawings in Figure 6

The thickness of the cutting board is ¾ in.
The width of the cutting board is 7½ in.
The length of the cutting board is 11 in.
The radius of the rounded corner is 1¼ in.
The diameter of the hole is ½ in.

The distance of the hole from the end is 1 in.
The distance of the hole from either edge is 3¾ in.

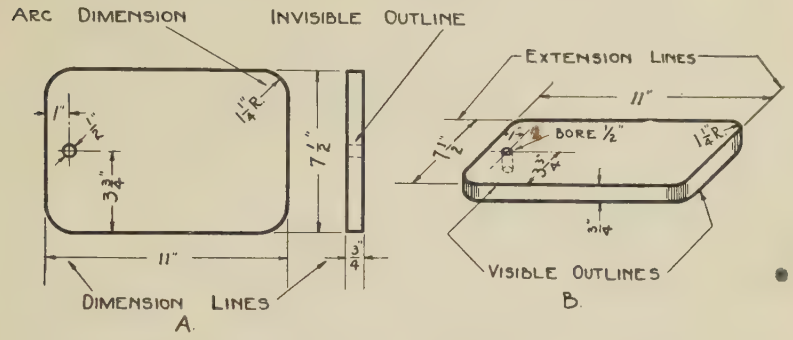


Fig. 6. An orthographic projection and oblique drawing of the same project (a cutting board)

4. Read a Working Drawing

Note the kind of drawing, the number of parts, the constructions and the dimensions. Fill in the following blanks:

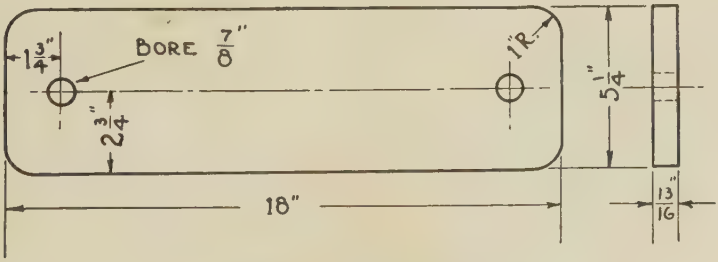


Fig. 7. A swing board

a) Refer to Figure 7, a Swing Board.

1. This type of drawing is an.....
2. The number of parts in the object is.....
3. The thickness of the board is.....
4. The width of the board is.....
5. The length of the board is.....
6. The radius of the rounded corners is.....
7. The number of holes in the board is.....
8. The diameter of the holes in the board is.....
9. The distance of each hole from the end is.....
10. The distance of the hole from either edge is.....

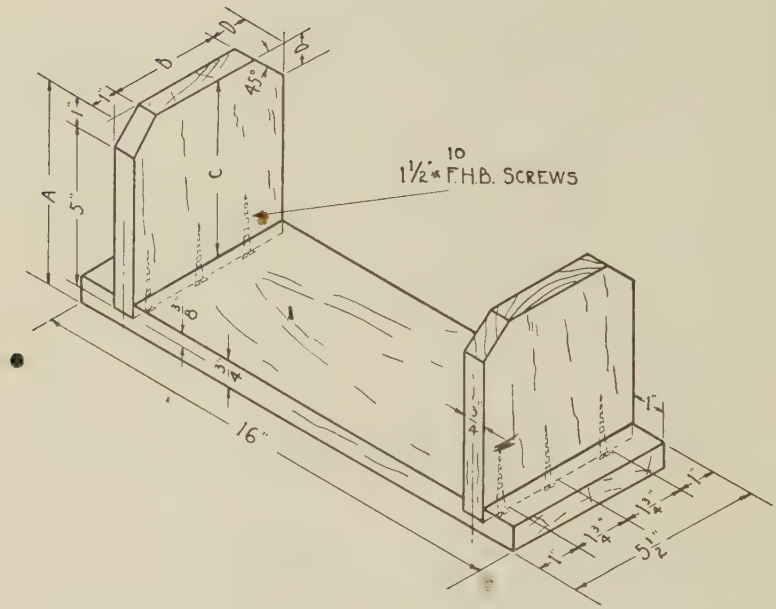


Fig. 8. Bookrack

b) Refer to Figure 8, a Bookrack.

1. This type of drawing is an.....
2. The number of parts in the bookrack is.....
3. The number of like parts in the bookrack is.....
4. The thickness of all the parts is.....
5. The width of all the parts is.....
6. The length of the base is.....
7. The length (height) of the ends is.....
8. The corners of the ends are cut off at an angle of.....
9. The depth of the joints (dado) in the base is.....
10. The width of the dadoes in the base is.....
11. The base projects from the upright ends.....
12. The dimension A is.....inches
13. The dimension B is.....inches
14. The dimension C is.....inches
15. The dimension D is.....inches

QUESTIONS:

1. What is the purpose of a working drawing?
2. Name the common types of working drawings.
3. How many views are shown in an orthographic projection?
4. How many faces are shown in an oblique drawing?
5. What are the advantages of a pictorial drawing?

6. What are the advantages of an orthographic projection?
7. What kind of line represents the visible outline of an object?
8. What kind of line represents the invisible outline of an object?
9. State a common use of center lines.
10. Name the line that is used to indicate the limits of a dimension line?
11. What is the purpose of a dimension line?
12. In reading dimensions, what is indicated by (*a*) 22; (*b*) 4 ft. —0 in.?
13. Illustrate two methods of indicating short dimensions.
14. What does the figure indicate when you dimension (*a*) an arc; (*b*) a circle?

REFERENCES:

FRENCH, T. E., *Engineering Drawing,* McGraw-Hill Book Co., New York, N. Y.

DIAMOND, THOS, *A Primer of Blue-Print Reading,* The Bruce Publishing Co., Milwaukee, Wis.

WYATT, E. M., *Blue Print Reading,* The Bruce Publishing Co., Milwaukee, Wis.

STURTEVANT, W. W., *Mechanical Pictorial Drawing,* The Bruce Publishing Co., Milwaukee, Wis.

SUGGESTED PROBLEMS:

a) Read the drawing in Figure 2, noting the method of construction and the number and size of parts. For irregular parts, use the largest dimension.

b) Read other drawings of projects you wish to make.

c) Transfer the dimensions from an oblique or isometric drawing to an orthographic projection of the same object.

UNIT 3

TO MAKE OUT A COMPLETE BILL OF MATERIAL

A bill of material for any project contains a list of the separate parts accurately dimensioned, a rough-stock list, together with a list of the lumber and other material necessary for its construction. It should also give the cost of the project. The making of such a bill gives training in the reading of drawings, in the dimensioning and ordering of lumber, and in figuring board feet and costs.

Lumber usually is sold by the board foot, and is quoted at so much per thousand (per M). A board foot is a unit of lumber measurement, 1 in. thick, 12 in. wide, and 1 ft. long. Lumber that is less than 1 in. in the rough, or less than 1 in. S 2 S (surfaced two sides), is sold by

STOCK BILL Name_____

Project Utility Bench

Date_____

No. of Pieces	Name of Part	Thickness (Inches)	Width (Inches)	Length (Inches)	Wood (Kind & Grade)	Cu. In. or Sq. In.	Bd. Ft. or Sq. Ft.	Rate per M	Cost	
Finished-Stock List										
2	Tops	3/4	4 1/2	30	No.1 Pine	270 cu.in.				
2	Rails	3/4	4 1/2	28	No.1 Pine	252 cu.in.				
2	Rails	3/4	4 1/2	9 1/2	No.1 Pine	82 cu.in.				
4	Legs	1 3/4	1 3/4	19 1/2	No.1 Pine	239 cu.in.				
						843 cu.in.	5.9 Bd.ft.	$100.00		.59
Rough-Stock List										
2	Tops	1	4 3/4	31	No.1 Pine					
2	Rails	1	4 3/4	29	No.1 Pine					
2	Rails	1	4 3/4	10	No.1 Pine					
4	Legs	2	2	21	No.1 Pine					
								Total		.59
								Percentage Added for Waste		.15
								Grand Total		.74

Fig. 9. Finished- and rough-stock lists for the bench in Figure 12. The approximate cost of the project may be figured from the finished-stock list, if desired

LUMBER BILL Name

Project Utility Bench

Date

No. of Pieces	Thickness (Inches)	Width (Inches)	Length (Ft. & In.)	Wood (Kind & Grade)	Bd. Ft. or Sq. Ft.	Rate per M	Cost	
1	1	10	6-0	No.1 Pine	5 Bd.ft.			
1	2	4	4-0	No.1 Pine	2⅔ Bd.ft.			
					7⅔ Bd.ft.	$100.00		.77
						Total		.77

Fig. 10. Lumber bill for the bench in Figure 12

the square foot. This is quoted at a certain price per thousand square feet for each thickness.

A bill of material is used in getting out the rough and finished stock for a project, in figuring the total cost, and serves as a valuable shop record.

Materials: A working drawing of the project to be made; blank forms (if available) for the bill of material.

PROCEDURE:

1. Make out Blank Forms

Bills can be made out best on blank forms. Figures 9, 10, and 11 show very complete forms for the different lists that may be desired. If blank forms are not furnished, make them out similar to the ones in the illustrations.

COMPLETE BILL OF MATERIAL

No.	Article	Description	Cost	
	Lumber	(Taken from Lumber Bill)		77
	Finishing Materials	Paint (2 coats)		20
32	Screws	1¼ No.10 f.h.b		10
16	Nails	8d Common		2
		Total	$1	09

Fig. 11. Complete bill of material for the bench in Figure 12

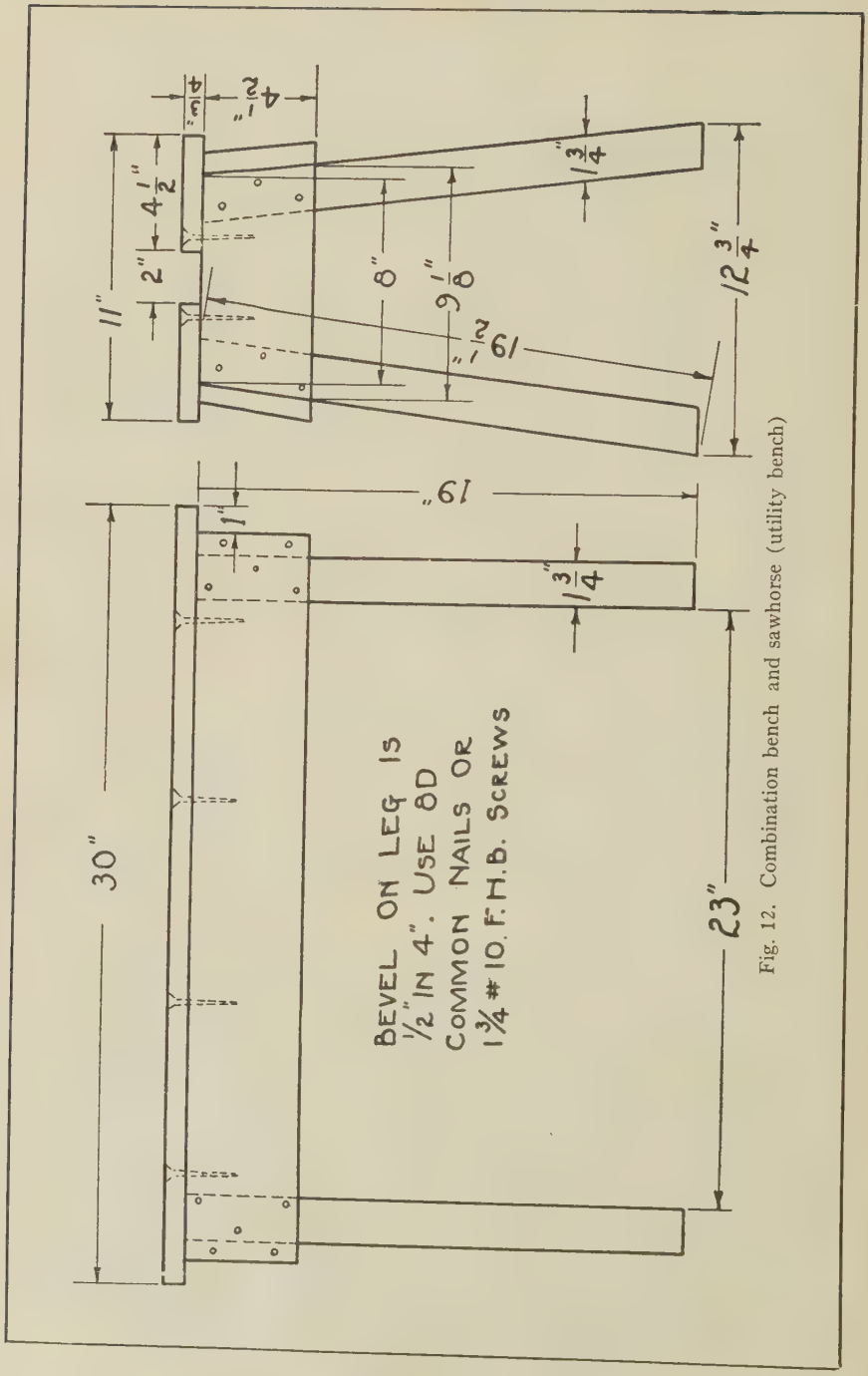


Fig. 12. Combination bench and sawhorse (utility bench)

2. Make Out a Finished-Stock List

The finished-stock list is a record of all the different parts (boards of a project) accurately dimensioned. This list is obtained directly from the working drawings. Figure 9 shows the finished-stock list for the project in Figure 12. Figure 13 shows the names of the surfaces and their intersections on any board which forms an individual part of any project. Figure 14 states the terms used in dimensioning such a board or part. The terms face, edge, end, corner, arris, length, width, and thickness, will be used frequently in describing boards, and it is well to note their meaning. Where parts are in duplicate (exactly alike), list the desired number. Read and record the finished dimensions of each part, together with the kind of wood desired. The order of stating the dimensions is (1) thickness, (2) width, and (3) length. For irregular shapes, record the largest over-all dimension. Make all

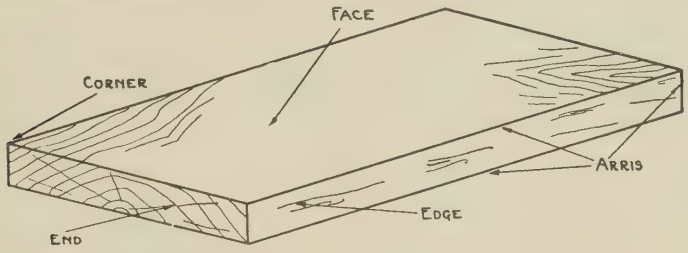


Fig. 13. Names of the surfaces and their intersections on a board

necessary allowances in any dimension for joints. Note that the thickness and width of a board are always measured across the grain and the length with the grain. (Fig. 14.) The length in the finished-stock list usually is given in inches rather than feet and inches.

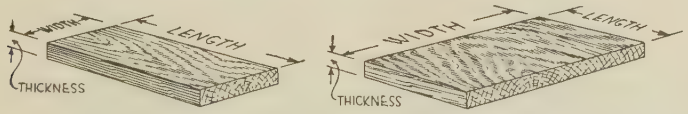


Fig. 14. The thickness and width of a board are always measured across the grain and the length with the grain

3. Figure the Approximate Cost of the Stock

If desired, the approximate cost of the stock can be figured from the finished-stock list. The accurate cost can be figured only from the lumber bill. (See step 6.) If the approximate cost is desired, figure as follows:

a) Place in one group all the pieces of the same kind and grade of wood that are ¾ in. or more in thickness. This will give as many groups as there are kinds of wood.

b) Place in separate groups all the pieces, of the same thickness and the same kind and grade of wood, that are less than ¾ in. in thickness. For example, all ⅝-in. pine would be put in one group, and all 7/16-in. pine in another group, etc.

c) Find the cubic inches in each piece in the first group, by multiplying together the three dimensions in inches, using 1 in. for the thickness for all stock ¾ in. to 1 in. Where the thickness is above 1 in., use the exact thickness. Find the total cubic inches in each group, and divide by 144 to get the board feet of each kind of wood. Multiply the total board feet by the price per foot to get the cost.

d) Find the number of square inches in each piece in the other groups, by multiplying the width in inches by the length in inches. Total the square inches for each group, and divide by 144 to find the square feet in that group. Find the cost of each group by multiplying the total square feet by the price per square foot.

e) Find the total cost by adding the separate costs of the groups. To this amount add 15 to 25 per cent for waste. This will give the approximate cost of the stock. (See Fig. 9 for the cost of the stock in the finished-stock list figured by this method.)

4. Make Out a Rough-Stock List

Thickness in Inches		Width in Inches	
Rough	S 2 S	Rough	Finished Width
3/8	3/16	2	1 5/8
1/2	5/16	3	2 5/8
5/8	7/16	4	3 5/8
3/4	9/16	5	4 5/8
1	25/32 to 13/16	6	5 5/8
1 1/4	1 1/16 to 1 1/8	8	7 1/2
1 1/2	1 5/16 to 1 3/8	10	9 1/2
2	1 5/8 to 1 3/4	12	11 1/2

Fig. 15. Minimum mill-surfaced thickness and width expected from rough lumber. "S 2 S" means surfaced (planed) two sides

The rough-stock list is made out from the finished-stock list and is conveniently added at the bottom of the form in Figure 9.

The *thickness* for the rough-stock list is taken from the table in Figure 15. Note that the allowance for S 2 S (surfaced two sides) lumber is at least 3/16 in. for thickness. Where additional surfacing or smoothing is necessary, make an allowance of about 1/16 in. more. For example, a piece of ¾-in. finished thickness would require 1-in. rough stock.

For *width,* the allowance is ¼ in. when the stock is got out in the shop. Note that the general allowance in the width of rough lumber is ⅜ to ½ in. (Fig. 15.)

For *length,* allow at least ½ to 1 in.

Finally determine the thickness necessary to produce each piece,

allow ¼ in. or more for width, ½ in. or more for length, and record the rough-stock list as in Figure 9.

5. Make Out a Lumber Bill

The lumber bill is the list of lumber necessary to make the project. It is made out from the rough-stock list. Group all the parts of the same kind of wood having the same thickness. Then select boards of sufficient width and length to make all of these parts. A sketch (Fig. 16) of the plan to be used for cutting up the boards will aid greatly in the conservation of the stock. Two or more narrow parts can often be ripped from wider stock to advantage. Tops and the like are often built up from narrow pieces. (See Unit 26.) Make your selection of lumber according to the table in Figure 15. The thickness and width,

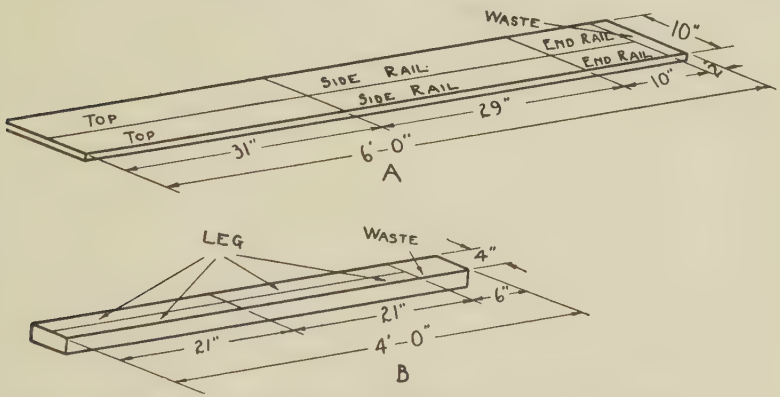


Fig. 16. Sketch of cutting plan for getting out the rough stock for the project in Figure 12. A, a board 1" x 10" — 6'; B, a board 2" x 4" — 4'

in the lumber bill, are always given in the rough dimensions. The length of softwood lumber is usually stated in even feet. Hardwood lumber can be purchased in odd feet. Calculate and record, in the lumber bill, the boards necessary for the project. Figure 10 shows the lumber bill made out from the rough-stock list in Figure 9.

6. Figure the Cost of Lumber

The exact cost of stock for a project may be figured from the lumber bill. Use the rough dimensions and find the board feet in each piece, *one inch or more in thickness,* by using the following formula:

$$\frac{\textit{Thickness in inches} \times \textit{width in inches} \times \textit{length in feet}}{12} = \text{board feet.}$$

Find the total board feet of each kind and grade of wood, and multiply by the price per foot to get the cost.

Lumber less than 1 in. in thickness in the rough, or less than 1 in. S 2 S, usually is sold by the square foot. Substitute 1 in. for the thickness in the above formula and the result will be the number of square feet. Multiply by the price per square foot to find the cost.

7. Make Complete Bill of Material

Make an itemized statement of all the material necessary to make a project. (Fig. 11.) Record the cost of the lumber taken from the finished-stock list or the lumber bill. Secure from the instructor an estimated cost of the finishing materials (varnish, paint etc.). List all other items, such as screws, hinges, locks, corner braces, corner plates, upholstering material, and the like. Record the description and cost of these. Add the separate costs to get the total cost of the project.

QUESTIONS:

1. What is a complete bill of material?
2. State two uses of a bill of material.
3. How is lumber usually sold?
4. What is a board foot?
5. What thickness of lumber is sold by the square foot?
6. What is the meaning of (*a*) "per M"; (*b*) "S 2 S"?
7. What is a finished-stock list?
8. What order should be used in stating the dimensions?
9. How is the length usually dimensioned in a finished-stock list?
10. How is the approximate cost figured from the finished-stock list?
11. Why is a percentage added to the approximate cost in a finished-stock list?
12. What is a rough-stock list?
13. In the rough-stock list, what allowance is usually made for (*a*) width, (*b*) length?
14. What is a lumber bill?
15. What finished width can be expected from (*a*) a 6-in. rough board, (*b*) a 10-in. rough board?
16. What is the usual S 2 S thickness of a 1-in. rough board?
17. State the formula for figuring board feet.
18. How do you figure the square feet of lumber?
19. What are the advantages of making out a complete bill of materials?

SUGGESTED PROBLEMS:

1. Make out bills of material for the projects in Figures 2 and 8.
2. Make out other bills of materials for projects.

UNIT 4

TO MEASURE

(Using the Common Woodworking Rules)

Measuring involves two processes: first, *to lay off* a specified dimension taken from the drawing or stock list; second, *to determine* a dimension by the actual measurement of the piece. Woodworker's rules are used in both operations.

A measurement indicates the number of units in a dimension. A measurement of 2½ ft. indicates that there are 2½ units of 1 ft. each in the distance stated.

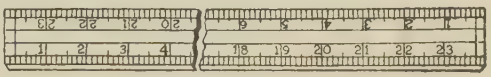


Fig. 17. Bench rule

Measuring is a fundamental operation in all trades. Each trade has its standard units and special measuring tools. The standard units of linear measurement for the woodworker are the foot and the inch. An inch is one twelfth of a foot. Projects in woodwork often are composed of a number of parts which must be exact in size in order to fit properly. The woodworker must therefore learn to measure accurately.

Tools: Woodworking rules; knife; pencil.

Material: Projects or stock to be measured.

PROCEDURE:

1. Note the Kinds of Rules Commonly Used in Woodwork

Bench rules (Fig. 17) are one-piece rules made in 1- and 2-ft. lengths. They are the tools commonly used for general measurement in school shops.

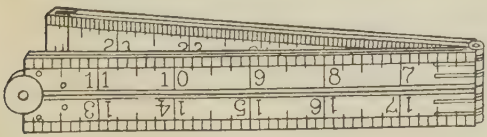


Fig. 18. Folding rule

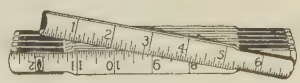


Fig. 19. Zigzag rule

The *2-ft. folding rule* (Fig. 18) is the typical carpenter's rule. Folding allows it to be carried conveniently in the pocket.

The *zigzag rules* (Fig. 19) are folding rules of various lengths. They

can be obtained in lengths of 3, 4, 5, 6, and 8 ft., and are used for measuring long distances in rough work.

The *caliper rule* (Fig. 20) is equipped with a caliper on one end, and is used for calipering outside dimensions. Rules of various lengths come equipped with a caliper.

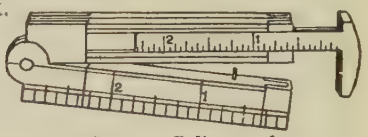



Fig. 20. Caliper rule

The *yardstick* is a one-piece, 3-ft. rule used for general measurement around the home. It is seldom used in the woodshop.

2. Note the Graduations on the Rules

Carefully examine the different rules that are available in the shop. The common graduations on rules are inches, half inches, quarter

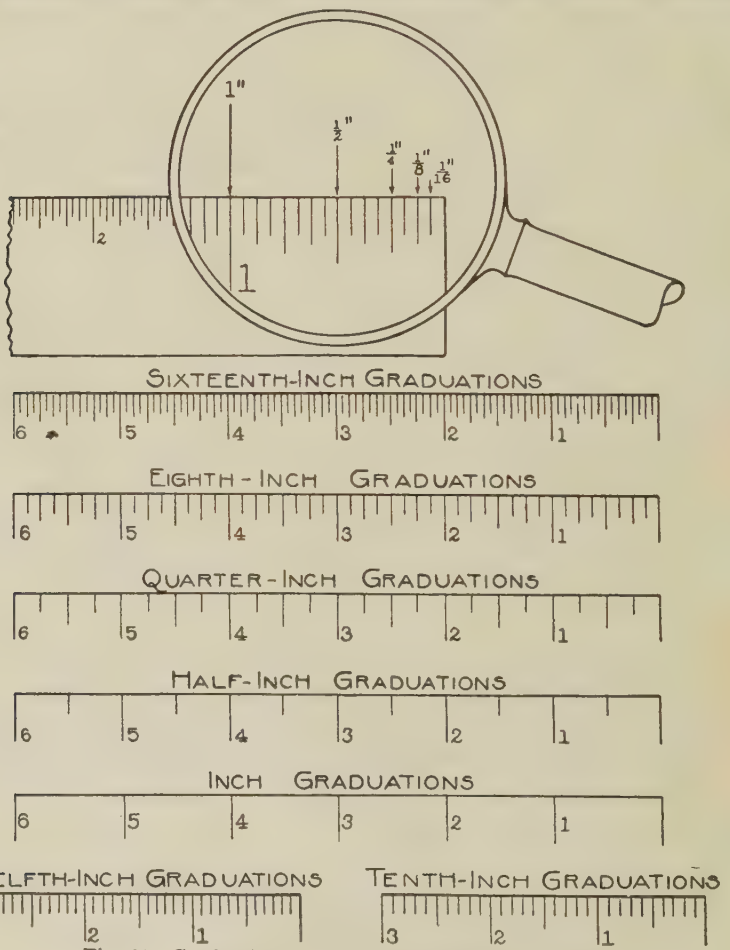


Fig. 21. Graduations found on woodworking rules

inches, eighth inches, and sixteenth inches. Some scales on rules have the inches divided into tenths and twelfths. (See Fig. 21.)

3. To Lay Off Short Distances

Distances less than the length of the rule are measured by placing the graduated edge of the rule in contact with the stock. This allows

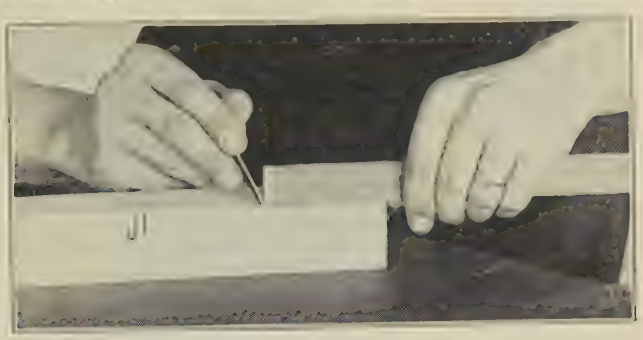


Fig. 22. To measure accurately, place the rule on edge. Mark with a knife

the knife or pencil mark to be placed exactly at the graduation desired. (Figs. 22 and 23.) If the end of the rule is worn, start at the 1-in. mark or any other graduation. A knife mark will give the most accurate measurement because of the thinness of the blade. Pencil marks

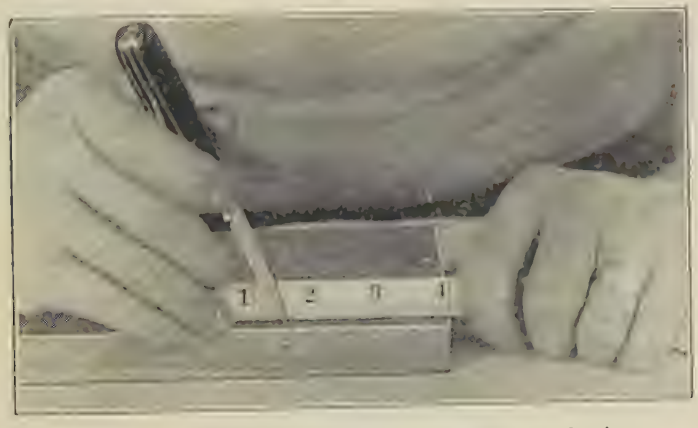


Fig. 23. Place the mark exactly opposite the graduation for accurate measurement

are more visible, and are used in rough measurements or where knife marks will mar the surface. Where several short distances in the same straight line are to be measured, place the rule in position and mark all desired points before moving the rule.

4. To Lay Off Distances Where the Rule Must be Moved

Use a long rule, because the longer the rule the more accurate the measurement. Long zigzag rules are very useful in measuring long distances. Measure carefully the full length of the rule, and place a mark exactly opposite the end. Move the rule in a straight line, preferably along an edge or arris. Mark carefully additional lengths of the rule. The last fractional length of the rule is measured as in step 3.

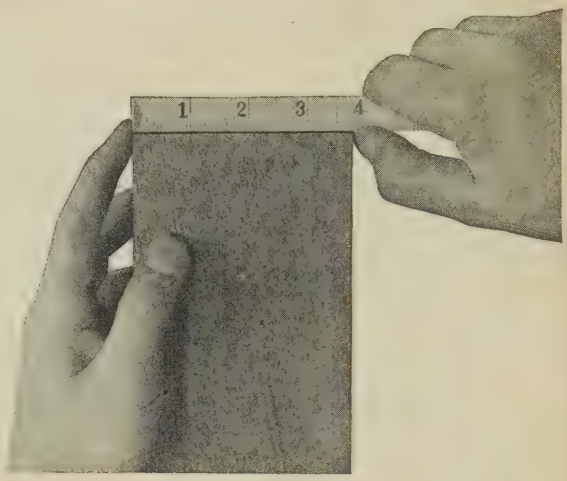


Fig. 24. Measuring accurately the width of a board

5. To Determine a Dimension

The operations are the same as in laying off, except that they are performed in the reverse order. Place the rule so that one end is exactly even (flush) with one of the limits of the dimension, and read the division on the scale that is exactly opposite the other limit. Figure 24 shows the method of measuring accurately the width of a board. Here the finger of one hand serves as a guide to hold the end of the rule flush with one edge, while the thumb nail of the other indicates the dimension.

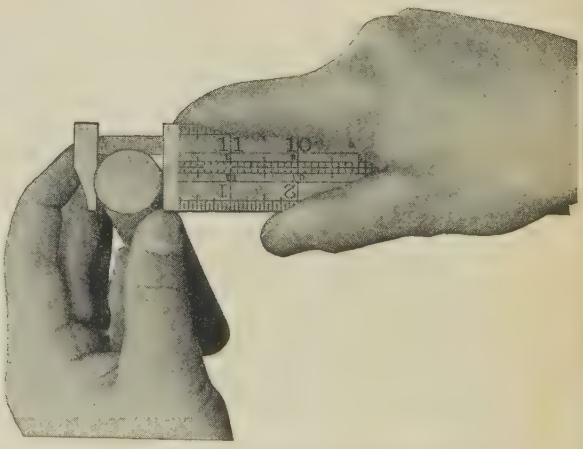


Fig. 25. Using a caliper rule to measure the diameter of a dowel

6. To Caliper With a Rule

Outside dimensions of circles are accurately determined with the caliper rule. Close the jaws tightly on the stock to be measured, and

read the dimension on the scale. Figure 25 shows the caliper rule used to accurately measure the diameter of a wooden dowel (round rod). Inside calipering can be accomplished by the use of a stick and a rule, or better by using two rules, as in Figure 26. Special calipering rules, similar to that shown in Figure 26, are manufactured for this purpose, but are rarely included in typical shop equipment.

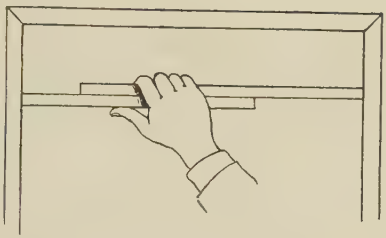


Fig. 26. Method of calipering an inside dimension with two rules or rule and stick

7. To Divide a Board Into a Number of Equal Parts With a Rule

Place the rule diagonally across the surface of the stock, so that the distance (from arris to arris) on the rule in whole inches can be evenly divided by the number of desired parts. This quotient in whole inches represents the distance on the diagonal for each part. (See Fig. 27.)

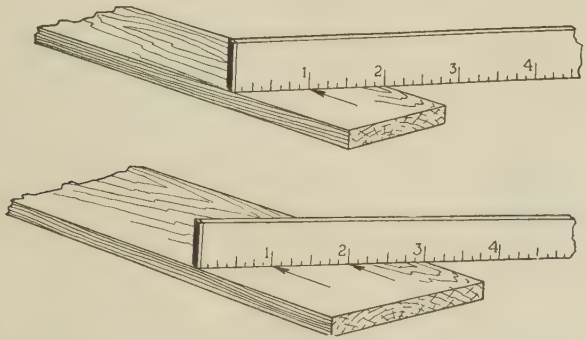


Fig. 27. Method of dividing a board into a number of equal parts

QUESTIONS:

1. Name the two uses of measurement.
2. What does measurement indicate?
3. What are the units of linear measurement in woodworking?
4. What is the object of measuring accurately?
5. Name three common woodworker's rules.
6. What are the advantages of a zigzag rule?
7. How can you measure accurately the diameter of a dowel?
8. List the common subdivisions of the inch.
9. What are the smallest graduations on the rule in Figure 24?

10. How is the rule placed in measuring short distances accurately?
11. What is the advantage of using a knife in marking?
12. When is a pencil used in marking for measurement?
13. Describe the method of dividing a 7⅝-in. board into three equal parts.
14. How would you find the center of a 5⅝-in. board?
15. What is the width of the board in Figure 24?

SUGGESTED PROBLEMS:

1. Measure the top of your woodworking bench, and record the dimensions.
2. Measure a model project, and make out a finished-stock list.

UNIT 5

TO LAY OUT LINES

(Using the Woodworker's Squares)

It is often necessary to lay out lines at right angles to a surface of a piece of stock. This is done before the stock is sawed to length, and in laying out for parts to be assembled at right angles. The tools used for this purpose are the *try-square* and the *framing square*. The *T bevel* is an adjustable square used for laying out lines at angles other than 90 degrees. For example, the T bevel would be used to lay out the lines for the bevel cuts on the legs of a sawhorse, and the like. The skilled carpenter also uses the framing square to lay out angular lines. The square has tables for this purpose. In addition to laying out angles, squares are used for testing angles. The operation is performed in a similar manner. The usefulness of squares depends upon their accuracy; they should, therefore, not be used for hammering, prying, scraping, or other similar operations.

Tools: Woodworker's squares; knife; pencil; rule.

Materials: Stock to be laid out.

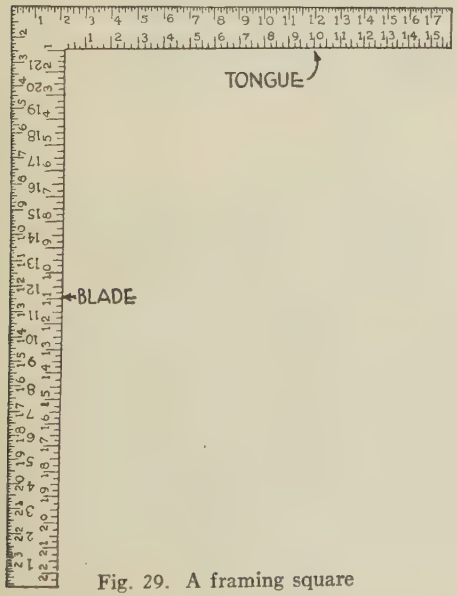


Fig. 29. A framing square

Fig. 28.
Try-square

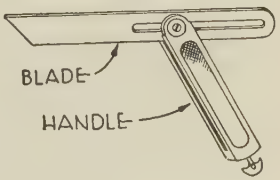


Fig. 30. A sliding T bevel square

PROCEDURE:

1. Note the Common Woodworking Squares

The common woodworking squares are shown in Figures 28, 29, and 30. The arms of a try-square and framing square are at 90 degrees, or a right angle. The T bevel is adjustable to any angle up to 180 degrees. The try-square is used for laying out right-angle lines in cabinetmaking and fine-finish work, while the framing square is used mostly in rough work and carpentry. Compare the names of the arms of the different squares. Note the inch and fractional graduations on the blade of the try-square and on the blade and tongue of the framing square. The tables on the framing square are for board measure and brace or rafter measure. These are of use to the carpenter in laying out braces and rafters.

2. To Square a Line Across the Face of a Board With a Try-Square

A line is squared across the face of a board to make the line perpendicular to the edge. Measure with a rule to mark the exact position of the line on the face. Place the handle of the try-square

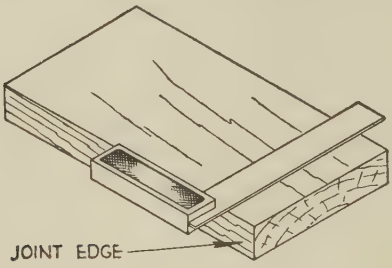


Fig. 31. Use the "joint edge" to square a line across the face of a finished board

firmly against the edge of the stock. On rough lumber, use the straightest edge of the board for the guide. On finished stock, use the edge that was first planed true. (Fig. 31.) This edge is referred to as the "joint edge," and is used as the basis for all squaring and measurement from an edge. It is extremely necessary to hold the handle firmly against the edge to insure a line at right angles. See that the blade is in line with the determined mark. Draw the line to coincide exactly with the mark, using a knife or pencil. Use a knife for a fine layout (Fig. 32), and a pencil for rough work or where a knife line would mar the finished surface. (Fig. 33.) Lines are squared in a similar manner with a framing square, but the blade is

Fig. 32. Use a knife for accurate layout

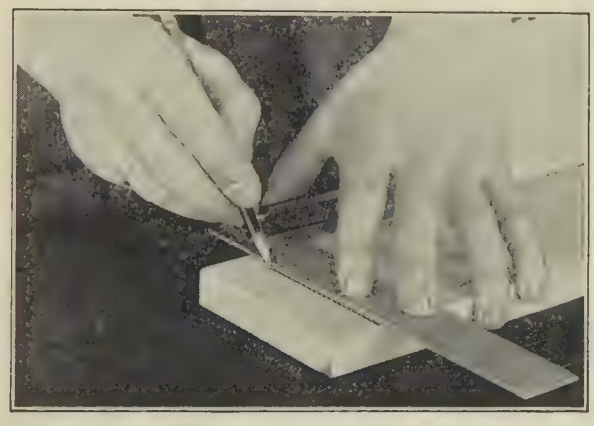


Fig. 33. Use a pencil when a knife line would mar the surface. Also use a pencil on rough stock

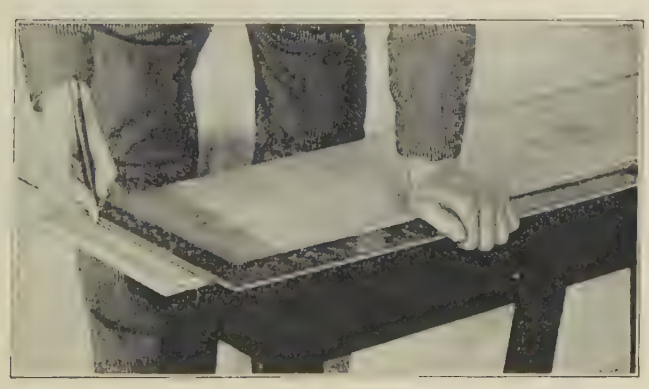


Fig. 34. Squaring a line with a framing square

commonly used for the handle, and the tongue for the marking guide (Fig. 34.)

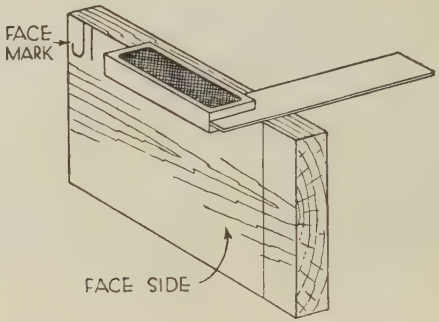


Fig. 35. Use the "face side" to square lines across the edges. Note the face mark to indicate the face side

3. To Square Lines Across the Edges of a Board from the Face

Place the handle of the try-square firmly against the face, so that the edge of the blade is in perfect alignment with the line on the face. In finished work, this face is called the "face side" and is the side selected as the best or the first to be planed true. (Fig. 35.) Mark with a knife or pencil. (Fig. 36.) Note the face marks on the face sides at the intersection with the joint edges in Figures 35 and 36. This mark distinguishes these two surfaces which are used as the basis for all squaring and measurement across the grain. The line on the other edge is squared in like manner from the same face. Use the framing square in a similar manner to perform the same operation.

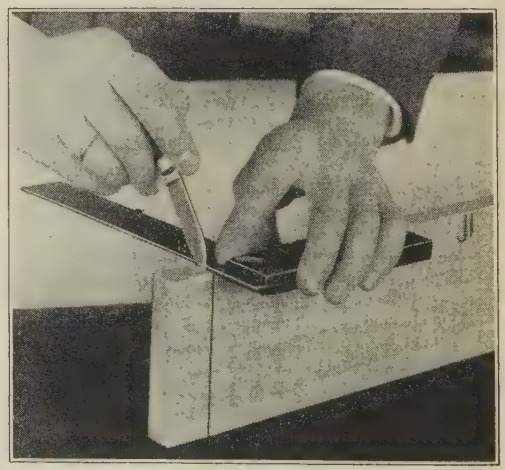


Fig. 36. Square lines across the edges from the face side

4. To Lay Out Angles Other Than 90 Degrees

The T bevel is often used for this purpose. It is adjustable when the thumbscrew in the handle is loosened. When setting, the thumb-

screw should be just tight enough so that the blade will move with slight pressure.

To *set an angle of 45 degrees by measurement,* use the framing square and the T bevel, as in Figure 37. Equal distances on the blade and tongue will give an angle of 45 degrees, or the angle of a miter joint.

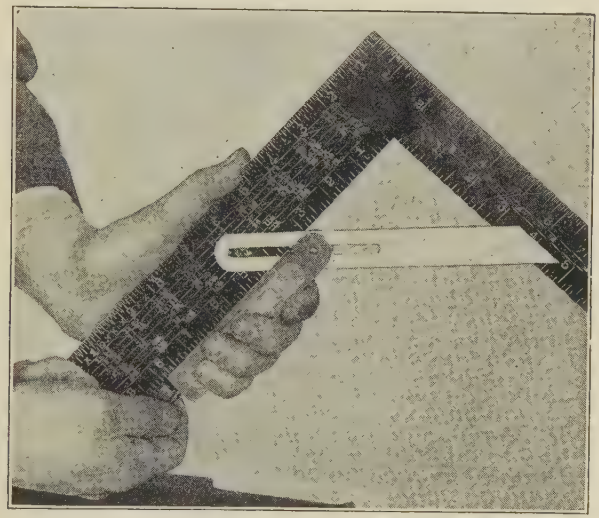


Fig. 37. Use equal distances on the blade and tongue to set a T bevel at 45 degrees

To *set angles of 30 and 60 degrees by measurement,* use a right triangle whose longest side (the hypotenuse) is twice the length of the shortest leg. Such a triangle contains angles of 30, 60, and 90 degrees. (Fig. 38.)

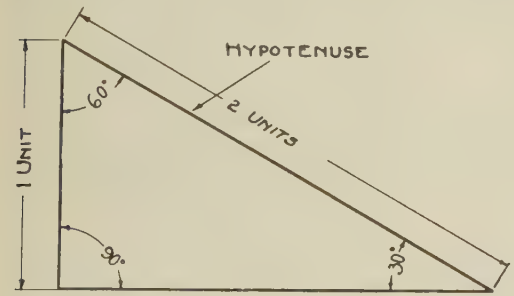


Fig. 38. A right triangle similar to the above gives angles of 30 and 60 degrees

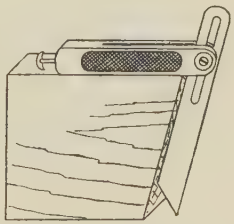


Fig. 39. Method of duplicating angles with a T bevel

To *duplicate angles,* fit the handle and blade of a T bevel tightly over an angle to be duplicated and tighten the setscrew. (Fig. 39.)

The T bevel can be set approximately at these angles, using the same method as in Figure 38, but using the distance 1¾ and 3 in. The carpenter often produces these angles by placing the framing

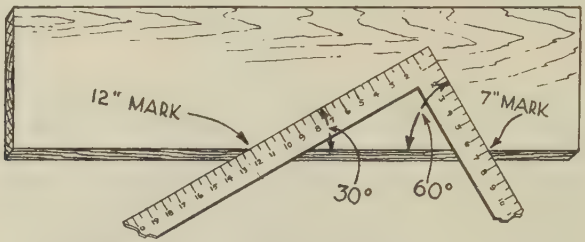


Fig. 40. Method of laying out angles of 30 degrees and 60 degrees with a framing square

square on the face of a board having a sharp arris and using the distances 7 and 12 in. (Fig. 40.) The above ratios are equal and produce 30- or 60-degree angles to within ¼ of a degree of accuracy.

QUESTIONS:

1. For what is the square commonly used?
2. What squares are used to lay out right angles?
3. Name the two arms of (*a*) a try-square; (*b*) a framing square.
4. What are the common uses of a framing square?
5. Where is a try-square used?
6. Why should squares be used only for the purposes intended?
7. How should the try-square be held when squaring a line?
8. How does a T bevel differ from a try-square?
9. What is the use of the T bevel?
10. How is a T bevel set at 45 degrees by measurement?
11. How would you construct a right triangle having angles of 30 or 60 degrees?
12. Describe the method of setting the T bevel by measurement at 30 degrees.
13. How does the carpenter lay out angles of 30 or 60 degrees directly on a board?

SUGGESTED PROBLEMS:

1. Square a line around a piece of stock.
2. Square lines across the face of a board for cutting to length.
3. Lay out on a board the parts taken from a rough-stock list. (Fig. 16.)
4. Set the T bevel (by measurement) at 30 degrees, 45 degrees, and 60 degrees.

UNIT 6

METHODS USED FOR GAUGING

Gauging is the process of drawing a line parallel to an edge or surface. The marking gauge is a special tool designed for accurate gauging from a planed edge or face. Rough gauging is accomplished with the finger and pencil or with the rule and pencil. The process of gauging is frequently performed by the woodworker to produce parallel lines.

Tools: Marking gauge; pencil; rule; mill file.

Material: Stock to be gauged.

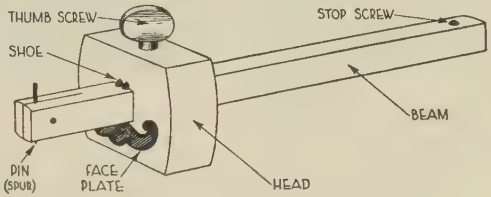


Fig. 41. The parts of a marking gauge

PROCEDURE A: To Gauge with a Marking Gauge

1. **Note the Parts of the Marking Gauge Shown in Figure 41**
2. **Sharpen and Adjust the Pin (Do only if necessary)**

The pin should be sharp to do good work. It often is sharpened to a conical point. (Fig. 42, A.) Some workmen prefer a knife edge. (Fig. 42, B.) If sharpening is necessary, loosen the setscrew, remove the pin, and file or grind. If sharpened to a knife edge, the edge of the pin should be set parallel with the head of the gauge. Adjust the pin so it projects about 1/16 to 1/8 in. below the beam. This will permit the beam to be rolled, bringing the pin into contact with the board at an angle. Tighten the setscrew to hold the adjusted pin securely.

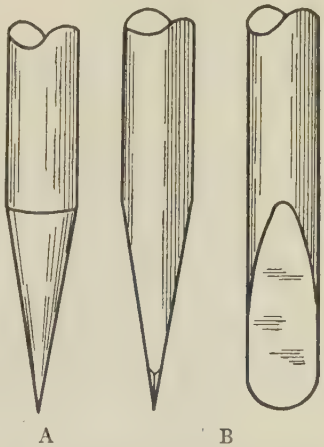


Fig. 42. The pin of a marking gauge may be sharpened to a conical point as in A, or to a knife edge as in B

3. Set the Gauge

For accurate work, it is necessary to measure the distance of the pin from the head with a rule, as in Figure 43. Tighten the thumbscrew, and again measure for the correctness of the setting.

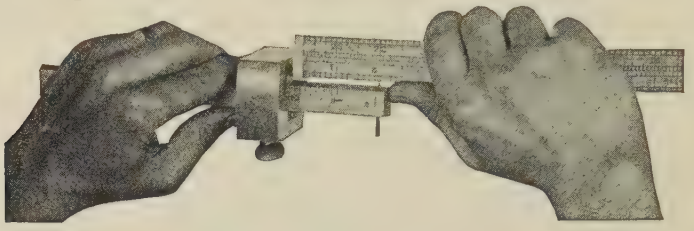


Fig. 43. Set the gauge with a rule

4. Gauge

Grasp the gauge as in Figure 44, so that the fingers encircle the head, and the thumb is on the beam behind the pin. The position of the head in the hand depends upon the width of the gauge being made.

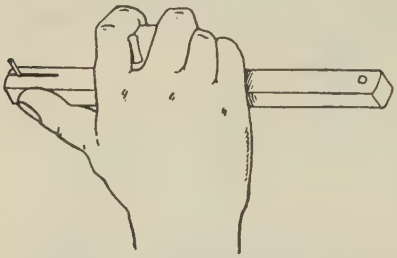


Fig. 44. Grasp the gauge so the fingers encircle the head, and the thumb is behind the pin

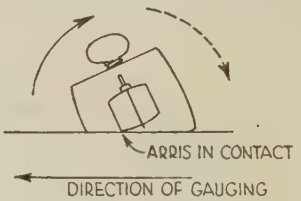


Fig. 45. Roll the gauge so the pin just touches the surface for a light gauge line

Lay the far bottom arris of the beam on the wood (Fig. 45) and roll the top of the gauge toward you so that the pin just touches the surface. Hold the head firmly against the guiding face of the stock, and begin to gauge at the end nearest you. Gauge by p u s h i n g from you, so that the gauge line is visible. (Fig. 46.) Distribute the p r e s s u r e evenly between the pin and the head. If necessary or desirable to gauge by pulling the gauge toward you,

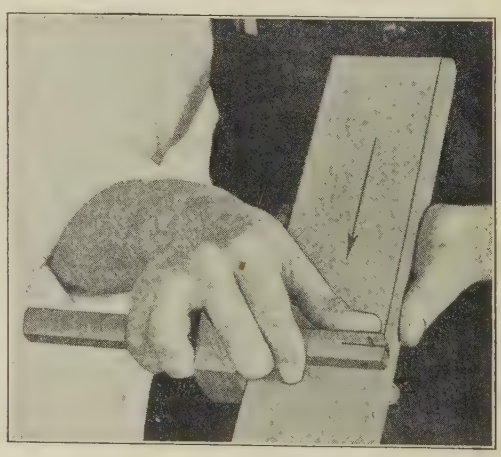


Fig. 46. Gauge by pushing from you whenever possible

revolve the gauge in the opposite direction. Make light lines. Avoid deep lines since they are liable to be inaccurate, especially when the grain of the wood is not parallel to the edge. Deep lines tend to follow the grain of the wood.

PROCEDURE B: To Pencil Gauge

Pencil gauging is used when the pin marks of the marking gauge will mar the surface of the stock. Since pencil marks do not cut into the wood, they can be easily removed. This method is desirable in beveling and chamfering. Hold the pencil in the position shown in Figure 47. Adjust the pencil, so that the point of the lead marks off the desired width. Push the pencil from you to prevent picking up slivers under the finger nails.

Fig. 47. Pencil gauging

PROCEDURE C: To Gauge with a Rule and a Pencil

This method is used in laying out rough stock for ripping, and in gauging distances too wide for the pencil-gauge method. The rule serves as the beam, the thumb serves as the head, and the pencil serves as the pin of the marking gauge. Adjust the thumb at the desired dimension on the rule, and gauge toward you, as in Figure 48. The carpenter often walks the entire length of long pieces in gauging

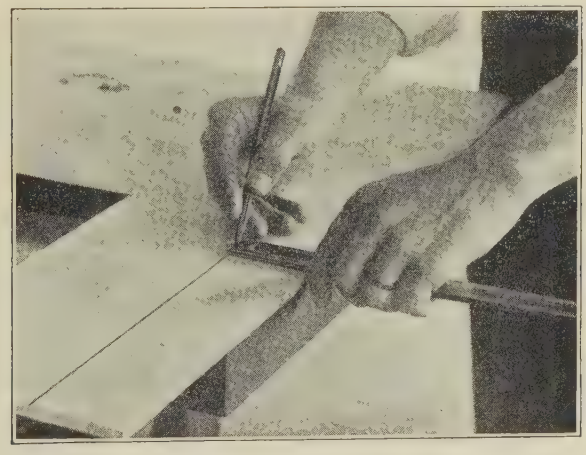


Fig. 48. Gauging with rule and pencil

with the rule and pencil. When the edge of the board is not straight enough for rule-and-pencil gauging, use a board with a straight edge, called a "straightedge," to lay out the desired parallel lines.

QUESTIONS:

1. What is gauging?
2. Name the parts of the marking gauge.
3. When is the marking gauge used?
4. How should the pin be sharpened?
5. How far should the pin project beneath the beam?
6. Why do you check the setting of the marking gauge with a rule?
7. How should the gauge be held when gauging?
8. What is the advantage of gauging from you?
9. Why is the head of the gauge held firmly against the guiding face of the stock?
10. Why do you avoid deep lines in gauging?
11. What is the advantage of pencil gauging?
12. When do you use the rule and pencil in gauging?
13. When do you use a straightedge to lay out parallel lines?

SUGGESTED PROBLEMS:

1. Sharpen and adjust the pin of a marking gauge, and set to a desired dimension.
2. Rule-and-pencil gauge a board for ripping. (See Unit 7.)
3. Pencil gauge for a chamfer. (See Unit 16.)

UNIT 7

TO SAW TO STRAIGHT LINES

Sawing is one of the most common operations in woodwork. The names of the parts of a handsaw are shown in Figure 49. The number stamped on the heel indicates the number of points to the inch. The number of points is one more than the number of complete teeth to the inch. The length of the saw is the length of the cutting edge in inches. Saws are set to prevent the blade from binding. In setting, each tooth is bent directly opposite to the one preceding it in order to

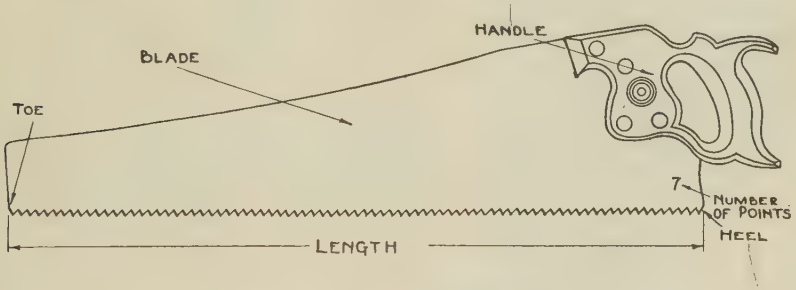


Fig. 49. The parts of a handsaw

make a cut (kerf) wider than the thickness of the blade. The proper amount of set in a saw is necessary if it is to cut easily. Saws must also be sharp to do good work. To select a sharp saw, examine the points of the teeth. Dull teeth will reflect the light and will appear as bright spots, whereas the sharp teeth will be invisible.

The crosscutting handsaw is used to cut across the grain, while the ripsaw is used to cut with the grain. The backsaw is used for fine, small work both across and with the grain.

Tools: Crosscutting handsaw; ripsaw; backsaw; laying-out tools.
Material: Stock to be sawed.

PROCEDURE A: To Crosscut with a Handsaw

1. Select a Crosscutting Handsaw

Note the shape of the teeth of a crosscutting handsaw. Examine the two views shown in Figure 50. A crosscutting handsaw is distinguished by the shape of the teeth. Crosscutting-saw teeth are sharpened to a

point. The teeth are arranged to give two rows of points, one on each side of the saw, with a V groove in between. (Fig. 51.) In crosscutting, the fibers of the wood must be cut in two places. The two rows of points do this. (Fig. 51, B.) Sight down the cutting edge of the saw to observe the two rows of points and the V groove.

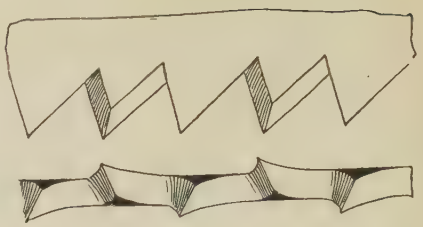


Fig. 50. Teeth of crosscutting saw

Note the number of points to the inch (stamped on the heel of the blade) and the length of the saw. Select a saw of 6, 7, or 8 points for rough work and 9, 10, 11, or 12 points for fine work. Saws 18 to 22 in. in length are better for small work or inconvenient positions. Saws 24 to 26 in. in length are more adaptable to large and heavy work. A crosscutting handsaw for general use is an 8 point, 26 in.

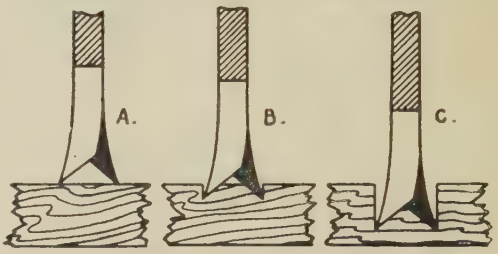


Fig. 51. Enlarged view showing V groove, cutting action, and set of a crosscutting saw

Select a sharp saw with set. Figure 51, C shows the set of a saw producing a kerf wider than the thickness of the blade. The amount of set of the saw should depend on the stock to be cut. Damp, soft, or spongy stock requires considerable set to prevent the saw from binding, while dry or hard woods require but little. For fine-finish work, use a saw with a small amount of set to produce a smoother cut. Some fine saws are made with a thin back and require no set. For rough work, select a saw with maximum set.

2. Layout for the Crosscutting

Use the framing square and pencil for laying out rough work, and the try-square or T bevel and knife for fine work. (See Figs. 34 and 32.)

3. Hold Stock Securely While Sawing

Clamp small pieces in the bench vise. Long pieces can be held securely in position on the sawhorse, as indicated in Figure 52. Sawing should always be done near a solid support to prevent vibration.

4. Crosscut to the Line

The saw kerf should be in the waste stock. In starting, guide the saw with the nail of the thumb of the other hand. Start the cut by pulling the saw backwards. For very accurate sawing, a V groove (Fig. 53) cut with a knife or chisel in the waste stock will help to start the kerf at the proper place. Take light, short, uniform strokes until the saw is well started. Adjust the cutting angle, so that the saw will cut smoothly and efficiently. If the saw jerks or vibrates, too little stock is in contact with the teeth. Decrease the cutting angle to eliminate this vibration. If the saw drags, due to sawdust fouling the kerf, too much stock is in contact with the teeth. In this case, increase the cutting angle. The average cutting angle is about 45 degrees. (Fig. 52.) To make a perpendicular cut, the blade of the saw must be held at right angles to the surface. Test this by sighting down the blade. The beginner may use the try-square to check this angle. (Fig. 54.) Saw just to line; that is, do not leave any wood between the line and the saw kerf. Use long, uniform strokes. Work slowly and do not force the saw. If the saw kerf tends to leave the line, slightly twist the saw in the proper direction as the sawing proceeds. When finishing the cut,

Fig. 52. Crosscutting on a sawhorse

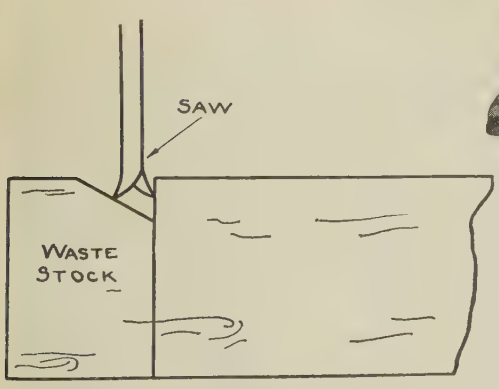


Fig. 53. A V groove in the waste stock will aid in starting the saw cut accurately

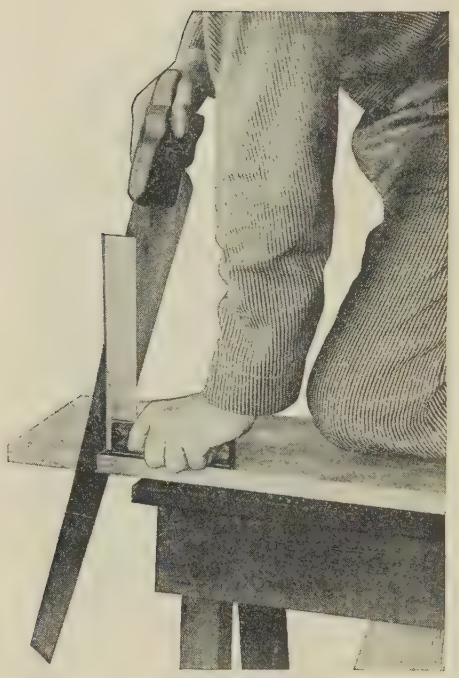


Fig. 54. The beginner may use a try-square in producing a square cut

Fig. 55. Support a piece being sawed off to prevent splitting

take light strokes and support the piece which is being sawed off. (Fig. 55.) This will prevent splitting the board.

PROCEDURE B: To Saw with a Backsaw

The backsaw is distinguished by the heavy steel back which supports the thin blade. The teeth are similar to those of a crosscut saw. It has very fine teeth and little or no set, since it is used for fine work where a smooth cut is desired.

To use the backsaw, lay out the lines and clamp the stock in the vise, or hold firmly against the bench hook. With the thumb or forefinger as a guide, start the

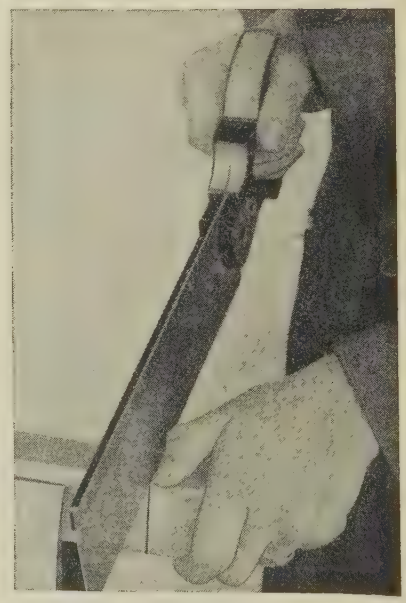


Fig. 56. Starting a cut with a backsaw

cut on the far edge, as shown in Figure 56. Use light, short strokes and gradually lower the handle until the saw is in a horizontal position. Saw slowly and carefully. Saw to the line in the waste stock, using uniform strokes.

PROCEDURE C: To Rip With a Handsaw

1. Select a Hand Ripsaw

Note the shape of the ripsaw teeth. (Fig. 57.) The teeth of a ripsaw usually are larger than those of a crosscut saw. Ripsaw teeth are shaped like chisels. They have a sharp cutting edge extending across the entire width of the tooth and do not come to a point like crosscutting teeth. The ends of the fibers of the wood must be cut off in ripping. The chisellike tooth performs this function.

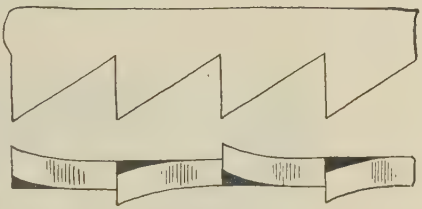


Fig. 57. Teeth of ripsaw

Note the number of points and the lengths of the saw. The common number of points on ripsaws is 4½, 5, 5½, 6, and 7. Select the larger teeth for heavy, rough work and the smaller teeth for light work. Ripsaws usually are made in 24-, 26-, and 28-in. lengths. A common ripsaw in general use is a 5½ point, 26 in. *Select a sharp saw with set.* Ripsaws usually have more set than crosscut saws, because there is more of a tendency for them to bind.

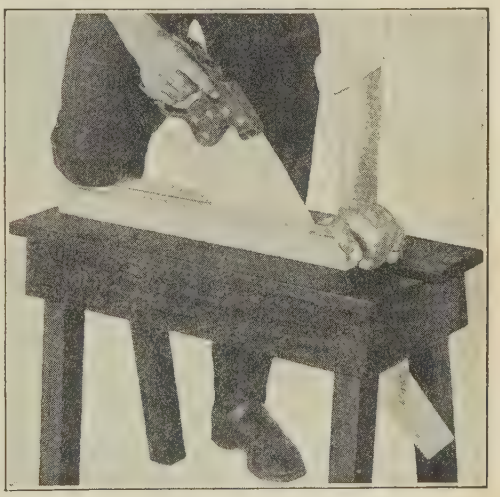


Fig. 58. Ripping on a sawhorse

2. Layout for Ripping

Use a marking gauge, rule, and pencil, or a straightedge. (Figs. 46 and 48.)

3. Hold the Stock While Ripping

Figure 58 shows the use of the sawhorse for holding the stock. Small pieces may be clamped in a vise. (Fig. 59.)

4. Rip to the Line

Rip in the waste stock just outside the line. Guide the saw with the thumb nail and start with short, light, uniform strokes. The cutting

edge should be at an angle of 45 to 60 degrees with the board for the best cutting. Rip with long, slow, uniform strokes, using the entire length of the saw. Keep the blade of the saw perpendicular to the board to make a square cut. The beginner may use a try-square as a guide if necessary. (Fig. 54.) In ripping long pieces, a wedge inserted in the kerf will keep the saw from binding.

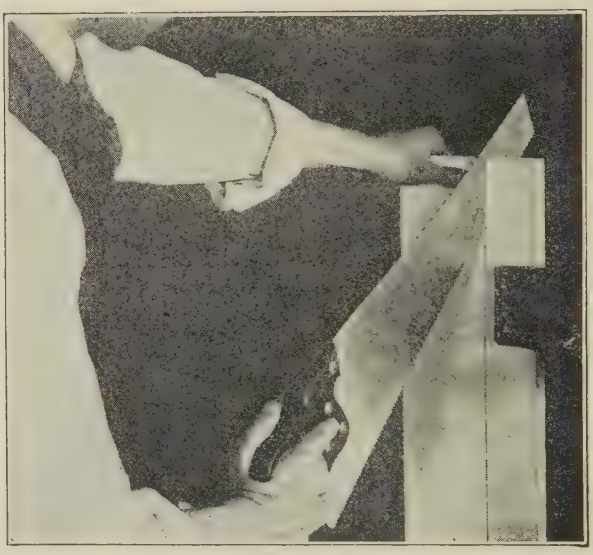


Fig. 59. Ripping in a vise

QUESTIONS:

1. Name two kinds of saws.
2. Name the parts of a saw.
3. What does the number on the heel of a saw indicate?
4. How is a saw set?
5. What is the purpose of set in a saw?
6. How do you detect a sharp saw?
7. For what is a backsaw used?
8. By what is a crosscutting handsaw distinguished?
9. What is the purpose of the two rows of points on a crosscutting saw?
10. What size (length and point) of crosscutting handsaw would you recommend for general use?
11. What is meant by sawing to the line? Where should the saw kerf be?
12. How do you start a crosscutting handsaw?
13. What kind of strokes are used after the saw has been well started?
14. What may cause a saw to jerk or vibrate? State the remedy.
15. Why should a piece that is being sawed off be supported?
16. What is the shape of ripsaw teeth?
17. How do crosscutting-saw teeth differ from ripsaw teeth?

18. How does the construction of a backsaw differ from the other handsaws?
19. What is meant by a saw kerf?

SUGGESTED PROBLEMS:

1. Crosscut and rip a board to desired dimensions.
2. Crosscut and rip stock to desired dimensions for a project.
3. Use a backsaw to cut small stock accurately.

UNIT 8

TO FIT A HANDSAW

"Fitting" a saw includes more than just sharpening the teeth. A sharp-toothed saw will not always cut well. Additional set may be required so that the saw will not bind. A high tooth may cause the saw to jump and vibrate, and top-jointing may be necessary. The teeth may not be of the proper shape to cut easily or in the proper alignment to produce a smooth cut. The expression "fitting a saw" applies to all of the operations that must be done to put the saw in the proper working condition.

Fitting a saw is a difficult job, and one which requires practice if it is to be done well. Unless one is going to use saws constantly, it is not advisable to spend the time necessary to develop the skill. However, it is well, for anyone who is to use saws, to know how it is done. Should you desire to learn how to do the job, practice on an old saw first.

Tools and Materials: Saw to be fitted; saw vise; mill file; taper file; saw set; oilstone.

PROCEDURE:

1. Clamp the Saw

Fasten the saw vise at the correct height. (Fig. 60.) This will permit free arm motion in filing. It is difficult to file a saw accurately if the

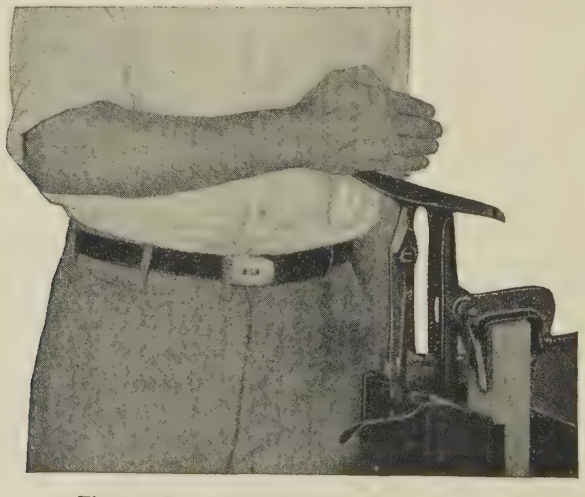


Fig. 60. Proper height of vise for saw filing

worker is in a cramped position. Clamp the saw securely to prevent vibration when filing. This will eliminate much of the unpleasant noise, and will aid in doing accurate work. Clamp the saw in the vise so that the cutting edge is horizontal and the blade perpendicular. Clamp the saw low in the vise (just so that the teeth are exposed) for filing. For top-jointing and setting, part of the blade should be above the jaws of the vise.

2. Top-Joint the Cutting Edge

The points of the teeth of a saw must be in line if each tooth is to do its share of the cutting. Use a saw jointer or a file as in Figure 61 to top-joint the saw. The stroke should continue the entire length of

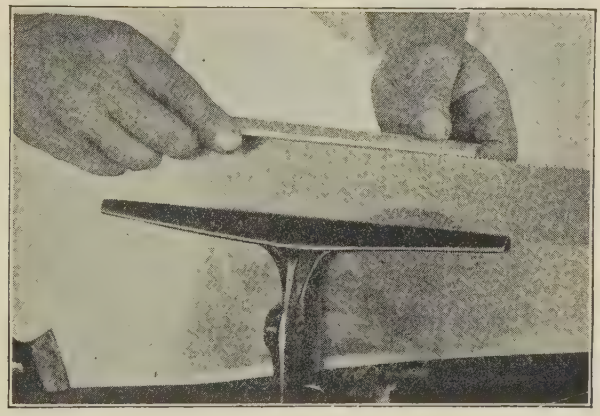


Fig. 61. Top-jointing a saw with a file

the cutting edge. Top-joint only until all the points are in line, that is, until there are no low teeth. Additional top-jointing will mean more work in filing. A saw in good shape requires little or no top-jointing. The cutting edges of rip and crosscut saws are crowned (convex). (Fig. 62.) The usual amount of crown varies from ⅛ to ½ in. The cutting edge of the backsaw is straight.

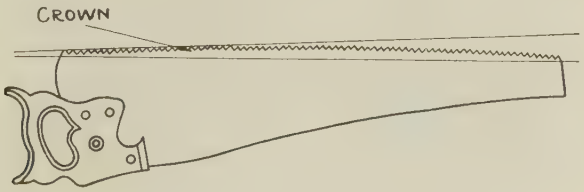


Fig. 62. The cutting edge of a handsaw is crowned (convex)

3. Select a File

Handsaws are filed with three-cornered taper files. The regular taper file, Figure 63, is used on saws with large teeth. The slim taper file is used on saws with smaller teeth. The slender taper permits a longer filing stroke. The extra-slim taper file, Figure 64, is used on fine-tooth saws, and permits an extra-long filing stroke. Double extra-slim taper files can also be purchased. Some mechanics prefer special blunt files which have no taper. However, the taper files are recommended for

Fig. 63. Regular taper file

Fig. 64. Extra-slim taper file

beginners. The files can be obtained in various lengths. The cross section of the file increases with the length. The angles are always the same, 60 degrees, since the files are three cornered.

Select a file that fits the saw teeth to be filed. Use a 4- or 4½-in. extra-slim taper file for filing a fine-tooth backsaw. A 6-in. extra-slim taper file would be a good selection for a 9-point crosscut saw. For a 6-point ripsaw, you may use a 6-in. slim taper or a 6-in. regular taper file.

4. Shape (File) the Teeth

(Omit this step when the teeth are in good shape.)

a) *Ripsaw*

Note the shape of the ripsaw teeth in Figure 57. They are filed at right angles, or nearly so, to the blade of the saw in both horizontal

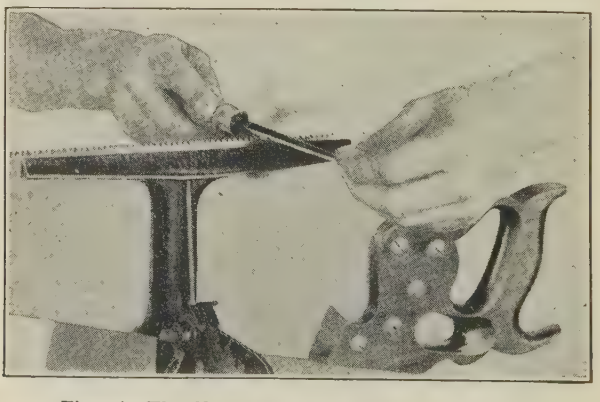


Fig. 65. The file usually is held in the horizontal position when filing ripsaw teeth

directions. Figure 65 shows the position of the file for filing ripsaw teeth. Sometimes the handle of the file is dropped a trifle from the horizontal. (Fig. 66.)

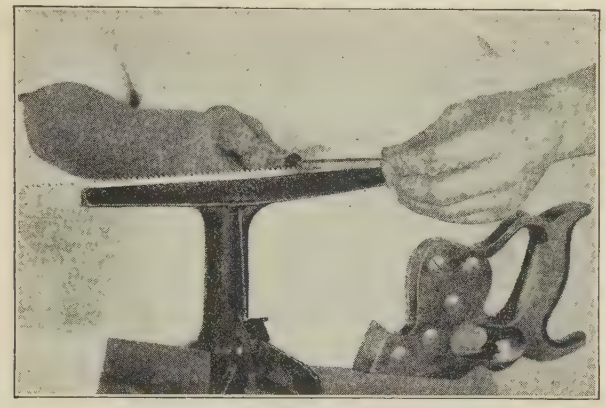


Fig. 66. Position of the file when the handle is dropped below the horizontal when filing ripsaw teeth

Shape five or six teeth at the heel of the saw and have your work checked by the instructor. When properly shaped, use these as a pattern for shaping the rest of the teeth. File each alternate tooth from one side, reverse the saw, and file the remaining teeth from the opposite side. Regulate the position of the file so that the cutting edge of the saw teeth will be filed at right angles to the line of points. (Fig. 67.) The number of strokes required depends on the condition of the teeth. Usually three or four uniform strokes on each tooth are enough. See that the file cuts on the front side of one tooth and the back side of the other. If the teeth are unequal in size, adjust the pressure on the file so that most of the cutting will take place on the larger tooth. Refer often to the pattern teeth that you filed at the heel of the saw. If the saw is in poor condition from previous filing, it may be necessary to go over the entire saw more than once to produce teeth of uniform size and shape.

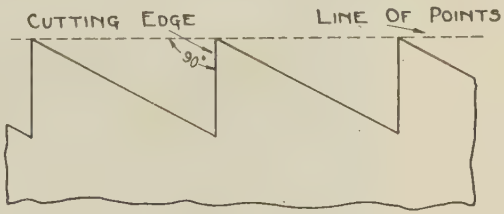


Fig. 67. The cutting edge of ripsaw teeth should be at right angles to the line of points

b) ***Crosscutting Saw***

Note the shape of crosscutting-saw teeth in Figure 50. Crosscutting-saw teeth are beveled; the file, therefore, must be held at an angle to produce the bevel. (Fig. 68.) The angle will vary according to the bevel desired for the work to be done with the saw. An angle of 45

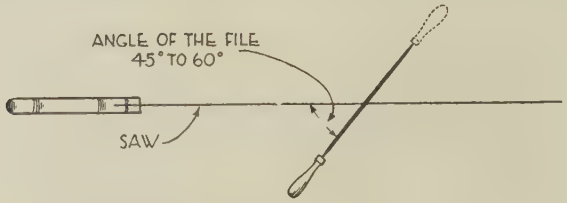


Fig. 68. File from either side

degrees will give a long bevel, and the saw will cut more rapidly but will not stand up as well. An angle of 55 to 60 degrees has been found to be most satisfactory for general use. The position of the file, in filing a hand crosscut saw from the heel toward the toe, is shown in

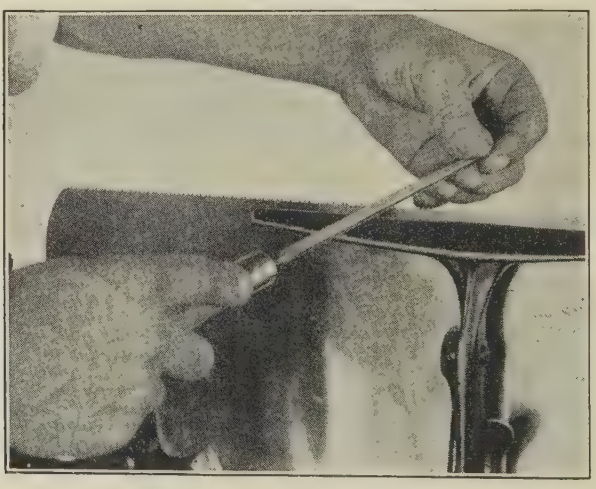


Fig. 69. Filing a crosscutting saw from the heel toward the toe

Figure 69. When the stroke of the file is made in this direction, a wire edge is formed on the cutting edge of the tooth. However, the wire edge can be removed by side jointing. Beginners can usually do more uniform work by using this method. Some expert saw filers file from

the toe toward the heel. The position of the file for this method is shown in Figure 70. In this case, less wire edge is formed on the cutting edge.

Shape five or six teeth at the heel of the saw and have them checked by the instructor. Use these as a pattern. The teeth must be filed

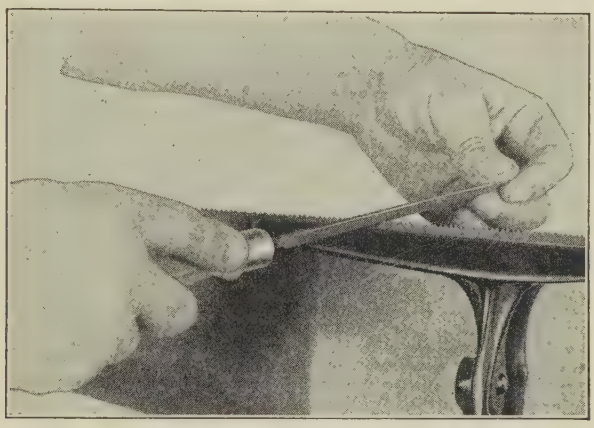


Fig. 70. Filing a crosscutting saw from the toe toward the heel.

alternately from opposite sides. Regulate the position of the file, so that the cutting edge will be set back one third of the width of the tooth, Figure 71, for average work. The angle formed between the cutting edge and a perpendicular to the line of points is called the "pitch" angle. This angle varies according to the work to be done. When the angle is small, Figure 71, the saw is said to have more "pitch" or "hook" than when the angle is larger. (Fig. 73.) With more pitch, the saw will cut more rapidly but will not produce as smooth a surface.

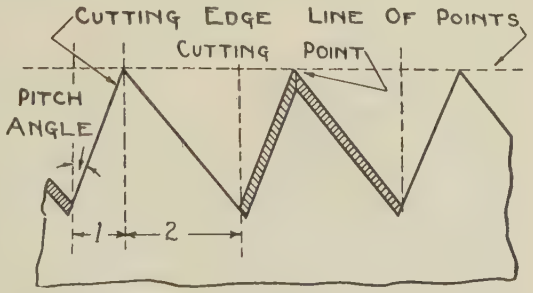


Fig. 71. Proper shape of crosscutting-saw teeth for average work

Use three or four uniform strokes on each alternate tooth. Reverse the saw, and file the other teeth from the opposite side. Adjust the pressure on the file, so that most of the cutting will take place on the larger tooth. Refer often to the pattern teeth. Do not attempt to file teeth here

and there. Go over the entire saw with three or four uniform strokes. Continue until the teeth are of uniform size and shape.

c) Backsaw

The shaping of the teeth of a backsaw, Figure 72, is similar to the method used for the crosscutting saw. The angle of the file, Figure 68,

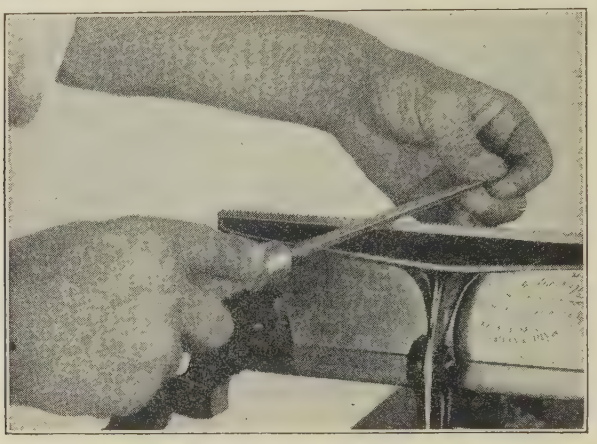


Fig. 72. Filing backsaw teeth from heel to toe

should be 60 degrees or slightly more. By increasing this angle, the teeth will resemble ripsaw teeth more closely and thus make the saw better suited for fine ripping. Backsaw teeth are given less pitch. (Fig. 73.) The cutting edge is set back about two fifths of the width of the tooth. Increasing the size of the pitch angle will aid in producing a smoother surface for fine work.

5. Set the Saw

Each alternate tooth is bent in the opposite direction to produce a kerf (cut) wider than the thickness of the saw blade. (Fig. 51, C.) The amount of set necessary to prevent the saw from binding varies according to the kind of material to be sawed. Damp, spongy woods require more set than dry, hard

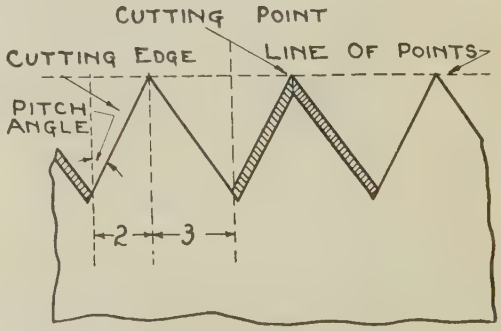


Fig. 73. Proper shape of backsaw teeth

woods. Determine the amount of set necessary, and set the teeth with a saw set, as in Figure 74. Each alternate tooth is set (bent) from one side. The saw is reversed, and the remaining teeth are set from the opposite side. Adjust the saw set so that the tooth will be bent at a point about one third of the length of the tooth from the cutting edge. Use care not to break the teeth in highly tempered saws. Since backsaws and fine, hand crosscutting saws are commonly used for finish work, very little or no set is required. For crosscutting and ripping in rough work, a wide saw kerf is often necessary. For average work, set the saw so that the width of the kerf produced will

Fig. 74. Setting a handsaw

be one and one-fourth to one and one-half times the thickness of the saw blade.

6. Point (File) the Saw

When the teeth have the proper shape and set, sharp cutting edges or points should be produced. Teeth are pointed (sharpened) in a manner similar to that used for shaping. Follow the procedure as given for each kind of saw in step 4. Use two or three *light,* uniform strokes on each tooth.

File each tooth to a sharp point or edge at the top-jointed line. Test the saw for sharpness by holding it in reflected light. The dull teeth will show up as bright spots, whereas the sharp teeth will be invisible. The teeth must be sharp and in line. These two conditions must be met if the saw is to work properly.

7. Side-Joint the Saw

Side-jointing, to remove the burr edge left from filing, is necessary where a smooth cut is desired. A sharp saw, properly side-jointed, will produce a cut nearly as smooth as if the surface had been planed. Even in rough work, the saw will cut easier and better if the sides of

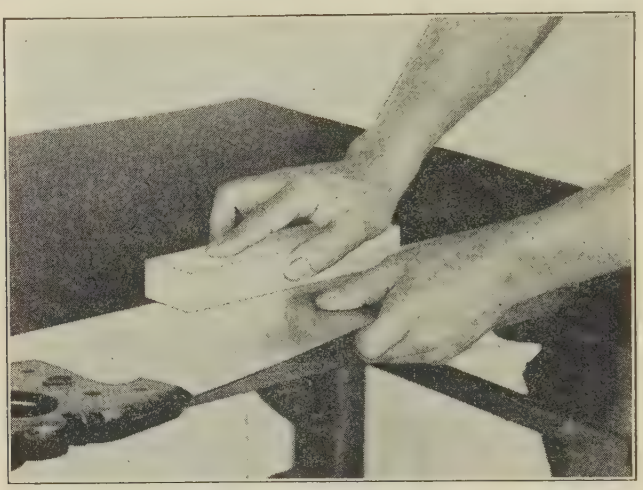


Fig. 75. Side-jointing a handsaw with an oilstone

the teeth are in line. Side-jointing may be accomplished with a file or with an oilstone, as shown in Figure 75. One or two light strokes on each side of the saw is usually all that is necessary. Note that side-jointing reduces the amount of set, and that the saw may bind as a result of an excessive amount of side-jointing.

QUESTIONS:

1. What is the meaning of the expression "fitting a saw"?
2. Will a saw with sharp teeth always cut well? Why?
3. Why is "fitting a saw" a difficult operation?
4. Why should an old saw be used to practice on?
5. How should a saw be clamped (*a*) for filing; (*b*) for top-jointing or setting?
6. What is top-jointing?
7. What is the crown in a rip or crosscutting saw?
8. Name three kinds of files used for filing saws.
9. What is the advantage of the slim, tapered file?
10. What is the position of the file for filing (*a*) ripsaw teeth; (*b*) crosscutting-saw teeth; (*c*) backsaw teeth?
11. Why should the beginner first file some teeth on the heel of the saw?
12. What is an average number of strokes to use in shaping the teeth of a saw?
13. How are irregular teeth made uniform in size?

14. How is the bevel produced on crosscutting and backsaw teeth?
15. What is the advantage in filing toward the cutting edge of crosscutting-saw teeth?
16. What is meant by the terms "pitch" or "hook"?
17. How is the pitch estimated?
18. Why do the backsaw teeth have less pitch than the crosscutting-saw teeth?
19. What is the purpose of set in a saw?
20. Where should the bend in the tooth be made?
21. How much set is necessary for average work?
22. What is meant by "pointing" the teeth?
23. In pointing the teeth, what two conditions must be observed?
24. Why is a saw side-jointed?
25. What will be the effect of too much side-jointing?

UNIT 9
TO SQUARE UP STOCK
ROUTING ORDER

Only rarely is rough stock used to make an object. Boxes and crates for shipping purposes are sometimes made of rough boards. In carpentry, the framework of the building is made of rough lumber.

There are many cases where it is necessary to reduce rough stock to finished dimensions and improve its appearance. This operation is called "squaring up stock." It is the second *major* operation that the woodworker performs in the construction of a project. Some of the processes learned in getting out the rough stock will be repeated, and other new processes must be learned. The new processes are confined mostly to planing, and the following units describe in detail how to use the common woodworker's planes.

This unit is the second routing order and must be used in connection with the units to which reference is made. Squaring up stock is an important operation and will be performed many times in the making of projects. The new processes necessary to be learned are: adjusting a plane, planing a broad surface, jointing an edge, and end planing. The order of performing the operations in squaring up stock varies, and the following routing plans are only two of several methods that are used. The instructions given in the following units cover completely the operations involved, regardless of the particular routing order used. The two procedures given are the routing orders commonly used. It is well to take greater care when sawing in squaring up stock than when getting out stock in the rough. Accurate sawing will often eliminate unnecessary planing.

Tools: Smooth, jack, or jointer planes; try-square; rule; knife or pencil; gauge; back or crosscutting saw.

Material: Rough stock to be squared.

PROCEDURE A:

1. **Assemble and adjust the plane.** (Unit 10.)
2. **Plane the face side.** (Unit 13.)
3. **Plane the joint edge.** (Unit 14.)
4. **Plane the second edge.** (Unit 14.)
5. **Plane the second side.** (Unit 13.)
6. **Saw the piece to length.** (Unit 7.)

PROCEDURE B:

1. **Assemble and adjust the plane. (Unit 10.)**
2. **Plane the face side. (Unit 13.)**
3. **Plane the joint edge. (Unit 14.)**
4. **Saw off one end. (Unit 7.)**
5. **Plane the end (if necessary). (Unit 15.)**
6. **Saw the piece to length. (Unit 7.)**
7. **Plane the end (if necessary). (Unit 15.)**
8. **Plane the second edge. (Unit 14.)**
9. **Plane the second side. (Unit 13.)**

QUESTIONS:

1. Where is rough stock or lumber sometimes used?
2. What is the meaning of "squaring up stock"?
3. What tool is used most frequently in "squaring up stock"?
4. Why is it well to saw accurately to the line in "squaring up stock"?
5. In "squaring up stock," is it always necessary to plane the end? Why?
6. Is it always desirable to follow the same procedure in "squaring up stock"?
7. Name the operations involved in "squaring up stock."

UNIT 10

TO ASSEMBLE AND ADJUST A PLANE

A plane is one of the common woodworking tools. It is used to reduce stock to the finished size, and for producing a smooth, straight surface. Because of its common use, it is desirable for anyone to be able to

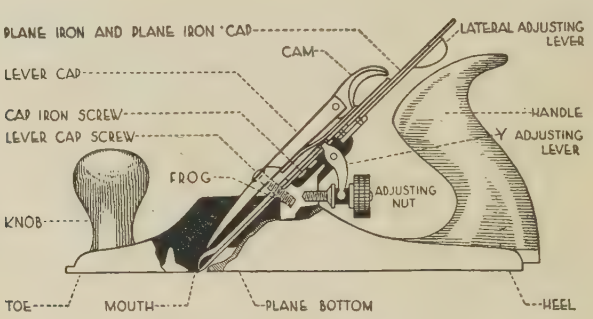


Fig. 76. Parts of a common plane

assemble and adjust a plane. The common planes used in the ordinary woodworking shop are the smooth, jack, and jointer. They are all made on the same plan, but vary in length.

Smooth planes range in length from 5½ to 10 in.
Jack planes range in length from 11 to 15 in.
Jointer planes range in length from 22 in. up.
The plane used most in the woodworking shop is the jack plane.

Tools: Jack, smooth, or jointer plane.
Material: Piece of stock to be planed.

PROCEDURE:

1. Remove the Plane Iron

Note the names of parts of a plane in Figure 76. Remove the lever cap by lifting the cam and pulling the lever cap up. Remove the double plane iron. (Fig. 77.) Use the lever cap as a screw driver, and loosen the cap screw which fastens the plane-iron cap to the plane iron. Slide

the plane-iron cap back from the cutting edge, and turn at right angles, using care to see that the plane-iron cap does not damage the cutting edge of the plane iron. Slide back the plane-iron cap, so that the head of the cap screw can be removed through a hole at the end of the slot in the plane iron.

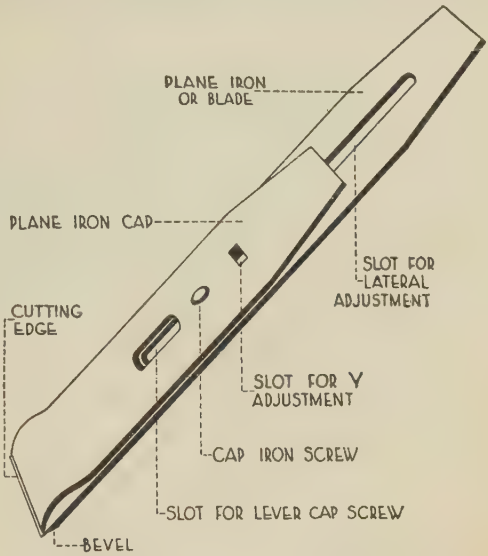


Fig. 77. A double plane iron

2. Examine the Plane Iron

Inspect the plane iron to see if it is sharp and properly ground for the job. You can detect a sharp plane iron as you did a saw. See Units 11 and 12 for testing and for grinding and whetting, if necessary.

3. Fasten the Plane-Iron Cap to the Plane Iron

Turn the plane-iron cap at right angles to the plane iron (Fig. 78, A) and insert the head of the cap screw through the hole at the end of the slot in the plane iron, so that the plane-iron cap will be on the straight side of the plane iron. Slide the plane-iron cap back from the cutting edge, as in B, Figure 78; then turn the cap parallel with the plane iron, as in C, Figure 78; finally slide the cap up to the cutting edge, as in D, Figure 78. Place the end of the cap from 1/32 to 1/16 in. from the cutting edge for rough work, and 1/64 in., or as close as it is possible to set it, for finish work, especially on hard woods. Set the cap screw tight, using the lever cap as a screw driver.

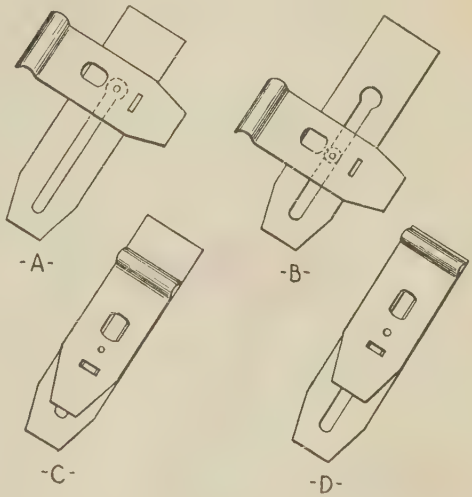


Fig. 78. Four steps in assembling a double plane iron

4. Place the Double Iron in the Plane and Clamp it in Place

Put the bevel side of the plane iron down on the frog. See that the end of the Y adjusting lever, which is regulated by an adjusting nut, fits into the slot in the plane-iron cap, and that the roller, regulated by the lateral adjusting lever, fits into the slot in the plane iron. (Fig. 79.) Put the lever cap in place by sliding under the lever-cap screw and pressing down the cam. The cam should snap easily in place. If it is too tight, slightly loosen the lever-cap screw. If the plane iron is not firmly held in place, tighten the lever-cap screw.

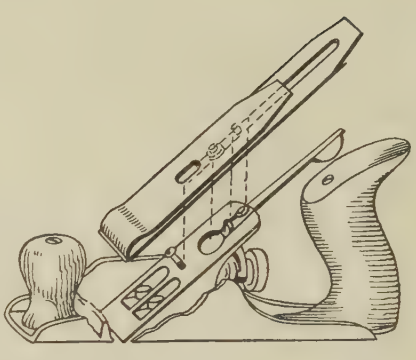


Fig. 79. Method of putting a double plane iron in place

5. Make Preliminary Depth Adjustment

Hold the plane with the bottom up and the toe toward the eye as in Figure 80. Regulate the adjusting nut, so that the cutting edge of the plane iron extends slightly through the mouth of the plane.

6. Make Lateral Adjustment

Hold the plane as in Figure 81. Shift the adjusting lever until the plane iron extends uniformly through the mouth. This adjustment must be very accurate to secure a shaving of uniform thickness throughout its width.

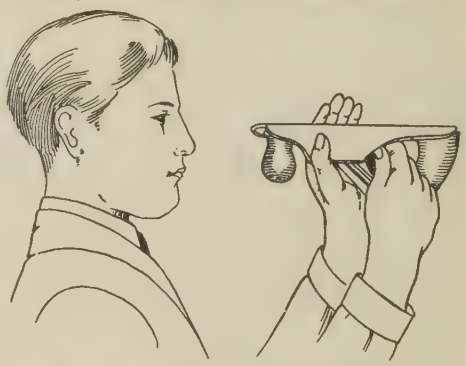


Fig. 80. Making depth adjustment of a plane iron

7. Adjust for the Depth of the Cut

Regulate the adjusting nut until the cutting edge can just be seen through the mouth. Attempt to plane, and by a slight readjustment of the nut, regulate the depth of the cut. Always finish the adjustment by turning the nut to force the blade out through the mouth. This takes up any slack in the adjustment.

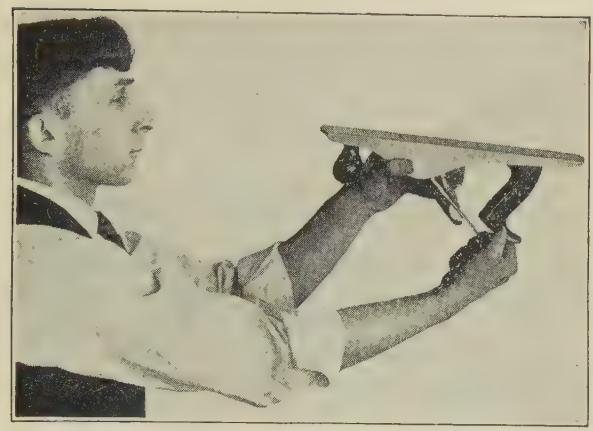


Fig. 81. Making lateral adjustment of the plane iron

QUESTIONS:

1. Name the common planes.
2. What is the use of the plane?
3. How long is a jointer plane?
4. What plane is used most in the shop?
5. How is the double plane iron removed?
6. How is the plane-iron cap removed from the plane iron?
7. How do you detect a sharp plane iron?
8. How is a double plane iron assembled?
9. How far back from the cutting edge should the end of the plane-iron cap be set for (*a*) rough work; (*b*) fine-finish work?
10. How is the depth adjustment made?
11. How is the lateral adjustment made?
12. Why make a lateral adjustment?
13. Why make a depth adjustment?

SUGGESTED PROBLEMS:

1. Assemble and adjust the different planes.
2. Assemble and adjust a jack plane ready for surfacing a board.

UNIT 11

TO GRIND A PLANE IRON

Cutting tools are ground to properly shape the edge and the bevel. Grinding, when necessary, will tend to keep tools sharp and in proper working condition. A plane iron should be ground when the cutting edge has nicks in it; when it is necessary to produce a new bevel due to continued whetting; or when careless whetting causes the bevel to become round or convex. (Fig. 82.) A rounded bevel does not allow proper clearance, and the plane iron tends to ride on the rear or rounded

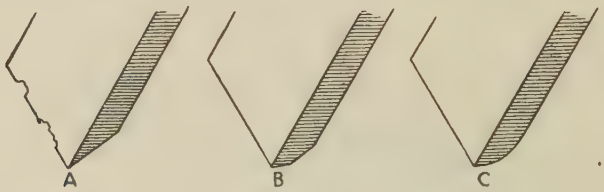


Fig. 82. A, a cutting edge with a nick in it; B, short bevel due to continued whetting; C, rounded bevel due to careless whetting

part of the bevel. In this case, even a keen edge will not produce satisfactory results. Electrically driven wheels are generally used for grinding. The wheel revolves toward the cutting edge. This helps to prevent the formation of a wire edge. The directions for grinding the plane iron apply generally to chisels and other bevel-edged tools. When grinding tools with high-speed wheels, goggles should be worn to protect the eyes from flying particles. The following procedure applies to the use of high-speed grinding wheels. The same instructions will apply when slow-speed oil grinders are used.

Tools: Grinder; try-square; screw driver, or lever cap.

Material: Double plane iron.

PROCEDURE:

1. Use Plane-Iron Cap as Guide

The plane-iron cap can be used very successfully as a guide in shaping the cutting edge, as it is practically square. However, it is well to check the cap for squareness with a try-square. If the edge of the plane-

iron cap is not straight and square, file it with a draw-filing stroke on the convex side. (Caution: It is only the plane-iron cap that is filed — not the plane iron.) Fasten the plane-iron cap in position on the plane iron, and set it back from the cutting edge 1/32 to 1/16 in. This is done

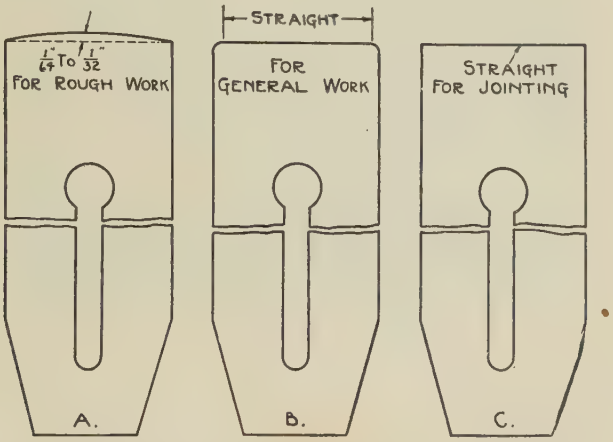


Fig. 83. Shapes of cutting edges for different kinds of work

so that the stone may not come in contact with the edge of the plane-iron cap.

Fig. 84. Shaping the cutting edge

2. Shape the Cutting Edge of the Plane Iron

The shape of the cutting edge of the plane iron should vary, depending on the work it is to do, as shown in Figure 83. Hold the double plane iron at right angles to the circumference of the stone, and shape to the determined cutting edge. (Fig. 84.) The edge of the plane-iron cap, acting as a guide, eliminates frequent removal of the plane iron to test with the try-square. Use very little pressure, and grind slowly. When the cutting edge is shaped, remove the plane-iron cap. Where only one plane iron is used, the edge

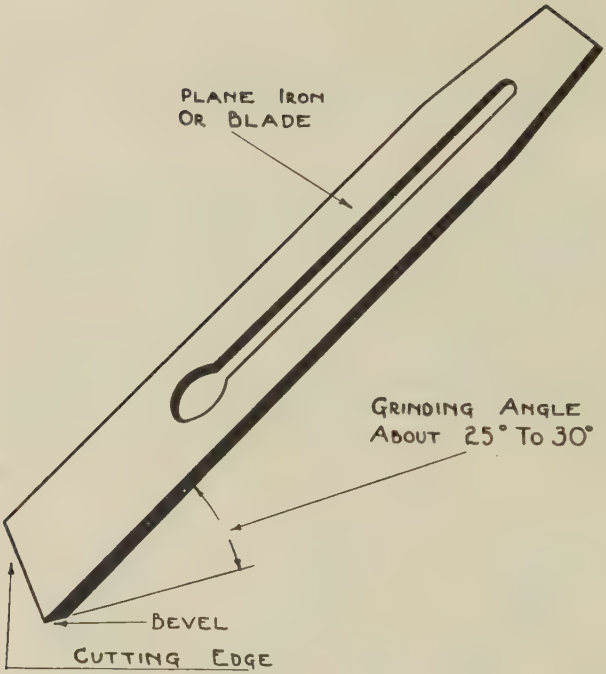


Fig. 85. Grinding angle for a plane iron

shown in B, Figure 83, is recommended for general use. For rough work only, use A, Figure 83; for jointing only, use C, Figure 83.

3. Adjust the Toolrest for Angle of 25 to 30 Degrees (Fig. 85)

A bevel, twice as long as the plane iron is thick, will give an angle of 30 degrees. If the bevel is two and one-third times as long as the plane iron is thick, the angle is 25 degrees. (Fig. 86.) The length of the bevel may also vary for different kinds of wood. A slightly longer bevel may be used in soft wood, but it would not stand up if used in hard wood. Have the adjustment of the toolrest checked by the instructor.

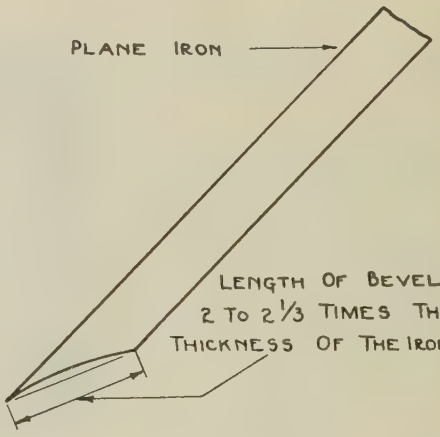


Fig. 86. Method of determining the proper grinding angle

Fig. 87. Grinding a plane iron

4. Grind the Bevel (Fig. 87)

Work back and forth across the face of the stone. (Fig. 88.) Apply a small amount of pressure. Hold one hand near the cutting edge, so that you can feel it getting warm. Dip it in water often to keep from burning the edge. It is impossible to put a keen edge on a tool that has been burned. A burned edge appears blue. Don't be in a hurry. Regulate the grinding, so that the plane iron will come to an edge throughout its entire width at the same time. This will give you a cutting edge of the correct shape. The plane iron is ready for whetting when properly ground. (See Unit 12.) Look at the edge for testing sharpness. Edges gradually disappear in reflected light as they become sharp. However, ground edges will never disappear entirely, due to the burr that is formed in grinding on a coarse stone.

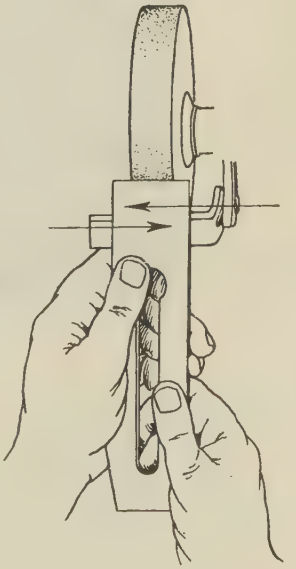


Fig. 88. Work back and forth across the face of the stone when grinding. This will produce a uniform bevel

QUESTIONS:

1. Why are tools ground?
2. When does a plane iron need to be ground?
3. Will a plane iron with a sharp edge always plane properly? Why?

4. Which way should the grinding wheel revolve? Why?
5. How are chisels and other bevel-edged tools ground?
6. What is the advantage of using the plane-iron cap as a guide in shaping the edge.
7. What is the shape of the cutting edge, (*a*) for rough work; (*b*) for general work; (*c*) for jointing?
8. At what angle is the bevel on a plane iron ground?
9. How is this angle measured or estimated?
10. Why is the plane iron moved back and forth across the face of the stone when grinding?
11. Why is the plane iron dipped in water when grinding on a high-speed wheel?
12. What is the effect of burning an edge tool?
13. How can you detect a burned edge?
14. When is the plane iron ready for whetting?

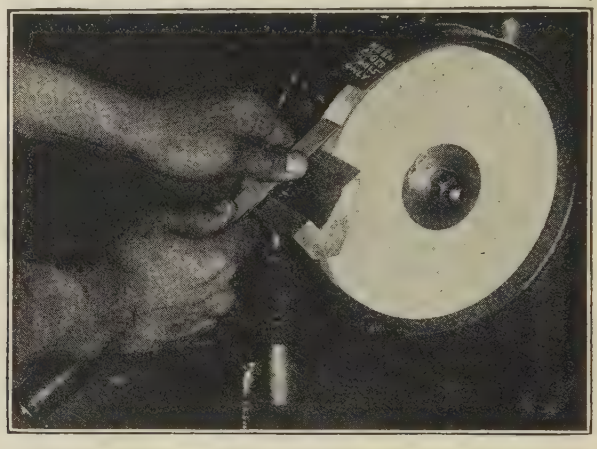


Fig. 89. Grinding a chisel

SUGGESTED PROBLEMS:

1. Grind different plane irons.
2. Grind a chisel. (Fig. 89.)
3. Grind a spokeshave blade.
4. Grind a drawknife.
5. Grind a knife.

UNIT 12

TO WHET A PLANE IRON, CHISEL, ETC.

Whetting is the process of putting a keen edge on a tool by honing. This is secured by rubbing the tool (usually by hand) over the surface of an oilstone. Sometimes it is more convenient to rub the stone over the bevel of the tool to produce a keen edge. In either case the result is the same. For plane irons and common chisels, the oilstone should be flat.

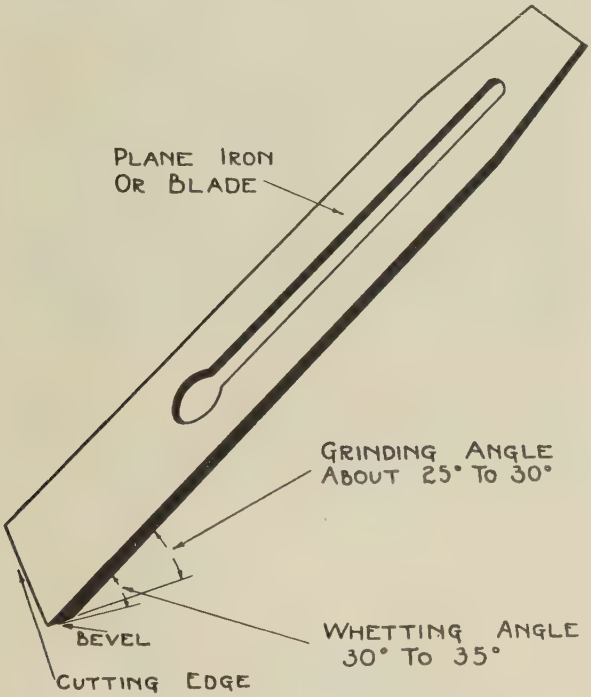


Fig. 90. Relative grinding and whetting angles for a plane iron

Whetting is done more often than grinding. The plane iron or chisel is always whetted after it is ground, and the edge can be kept sharp for some time by frequent whettings. (See Figure 90 for the relative angles of grinding and whetting.) A good workman always wants his tools sharp, because good results can be secured in less time and with less effort. A few minutes spent in whetting will keep the tools in good

condition. In addition to a plane iron, it is often necessary to whet a chisel or other bevel-edged tool. These were whetted in a similar manner.

Tools: Plane iron; coarse and fine oilstones.

Material: Oil; waste, or rag.

PROCEDURE:

1. Clean the Stone

With a piece of waste, or rag, clean the stone, to remove any dirt or grit on the surface. Particles of steel may have been left on the stone by the one who used it last.

2. Apply Oil to Stone

A mixture of one-half machine oil and one-half kerosene makes a good combination. Use a few drops of oil to prevent glazing, and to fill up the pores of the stone, so that all particles left on the surface may be wiped off.

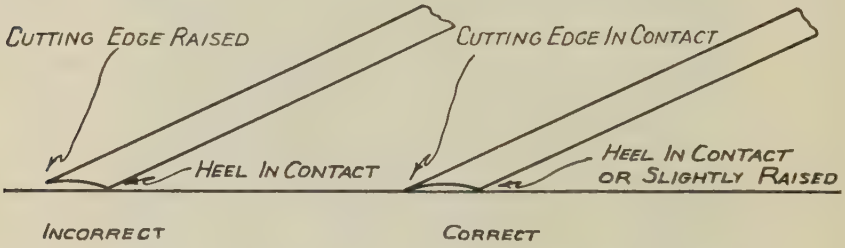


Fig. 91. Incorrect and correct positions of plane iron on stone

3. Place the Plane Iron in Proper Position on the Coarse Stone

(Fig. 91.) Make sure that the cutting edge is in contact with the stone. The heel of the bevel should also be in contact, or just slightly

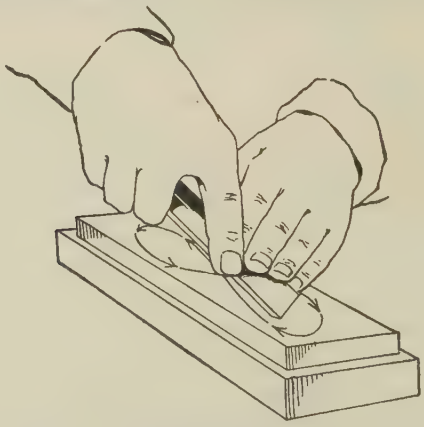


Fig. 92. A circular motion often used when whetting

raised. If these directions are not followed carefully, the plane iron may have to be reground.

4. Whet on Coarse Stone

With a circular movement similar to the figure 8 (Fig. 92), or with a back-and-forth motion (Fig. 93), whet the plane iron. It is most important in either method to keep the bevel flat on the stone. Rock-

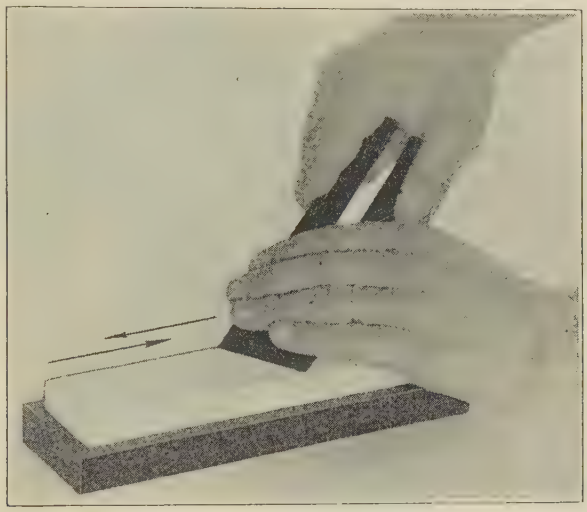


Fig. 93. Back-and-forth motion when whetting

ing the plane iron will produce a rounded bevel that will interfere with proper cutting. Use as much of the surface of the stone as possible in order to keep the stone flat. Apply a moderate amount of pressure as the plane iron comes to a keen edge. Remove the wire edge, which has formed on the unbeveled side, by holding the plane iron with the unbeveled side absolutely flat on the stone, as shown in Figure 94. Move back and forth, using care not to raise the plane iron while in motion. Raising the plane iron the slightest amount will produce a bevel on the flat side. This will allow shavings to collect between the plane iron and the cap iron

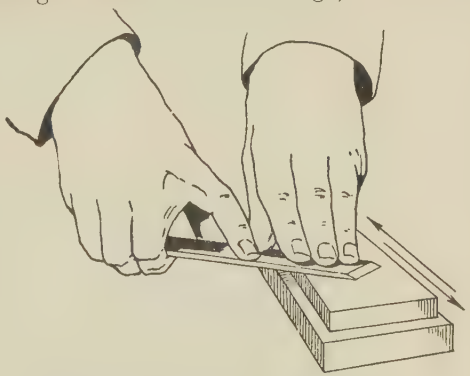


Fig. 94. Remove the wire edge with the unbeveled side flat on the stone

and thus clog the plane. Remove the wire edge during the whetting as often as it is formed.

5. Whet on Fine Stone

A finer edge can be secured by finishing on a fine-grained stone. Follow directions in steps 3 and 4 until the edge is sharp.

6. Test for Sharpness

Look at the edge in a bright light. If the edge is not sharp, it will reflect light and can be seen. If the edge cannot be seen, the plane iron is quite ready for use. If an additional check for sharpness is desired, test the edge with the thumb or fingers as in Figure 95. If the edge feels smooth and at the same time sticks, or pulls, as you draw your thumb lightly along it, it is sharp. Whet the plane iron until it meets the requirements of the above tests. When sharp, clean the plane iron.

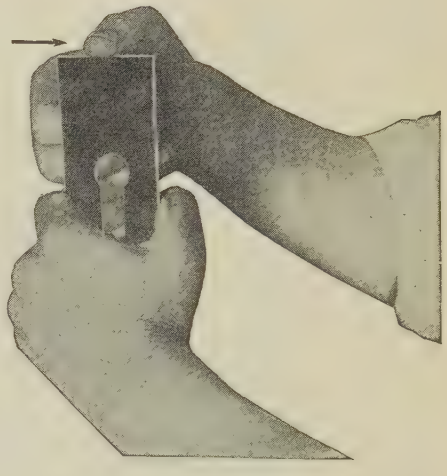


Fig. 95. Draw the thumb along the edge to test for sharpness

7. Clean the Stone and Replace the Cover

With a rag or piece of waste, wipe the stone thoroughly. This will remove any grit or particles of steel, and the stone will be in better shape for the one who is to use it next. Cover the stone to keep it clean.

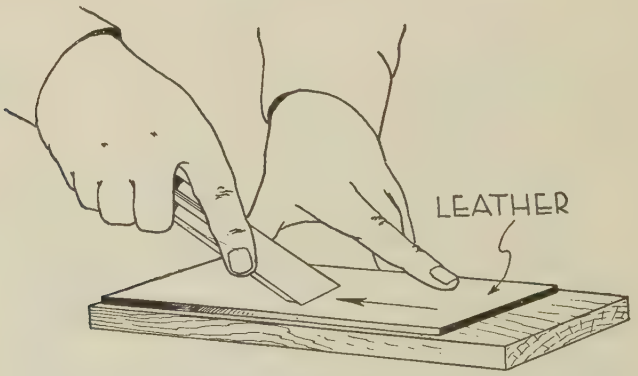


Fig. 96. Strop a blade by moving in the direction of the arrow. Lift and repeat for more strokes

8. Strop the Edge

If a keener edge is desired, strop by rubbing on a piece of leather. Drag the blade across the surface of the leather (Fig. 96), instead of pushing it. If the blade is pushed forward, it will cut the leather. Lift the blade from the surface on the forward stroke.

QUESTIONS:

1. What is whetting?
2. How is whetting accomplished?
3. What kind of surface should an oilstone have for whetting plane irons?
4. Is it necessary to whet a plane iron after every grinding?
5. Would you ever whet a plane iron without regrinding first?
6. What is the advantage of sharp tools?
7. How would you whet a chisel?
8. Why do you clean the stone before whetting?
9. What oil should be used in whetting?
10. Why do you use a coarse stone first?
11. Why must the plane iron be held in the correct position?
12. Why should you use the entire surface of the stone?
13. What is stropping?
14. What is the advantage of stropping?
15. How (only) must the tool be moved in stropping? Why?

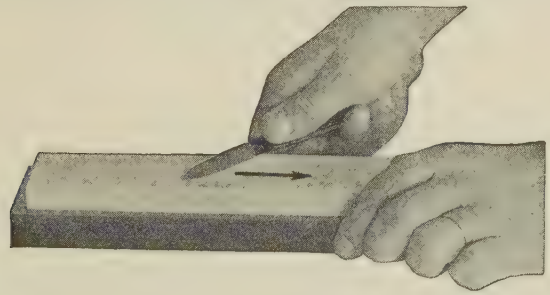


Fig. 97. To whet a knife, apply pressure when the direction of the stroke is toward the cutting edge, as indicated by the arrow

SUGGESTED PROBLEMS:

1. Whet a chisel (similar to a plane iron).
2. Whet a knife. (Fig. 97.)
3. Whet a drawknife. (Fig. 180.)
4. Whet a spokeshave. (Fig. 181.)
5. Whet a gouge. (Fig. 188.)

UNIT 13

TO PLANE A SURFACE

The first surface of a board usually planed is one of the broad faces. It is planed to make it smooth and true. (Fig. 98.) A true surface is one in which all the points are in the same plane. In squaring up stock,

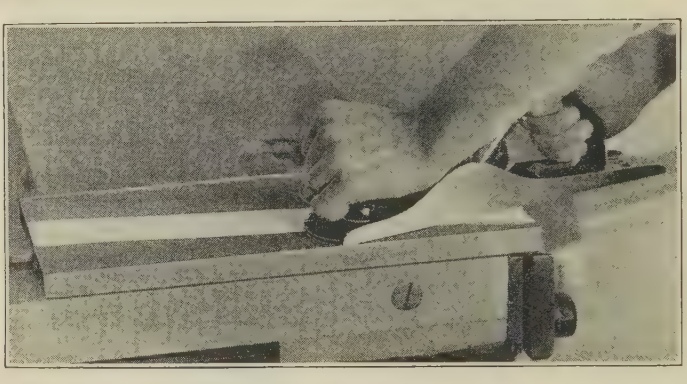


Fig. 98. Planing the broad surface of a board

this planed face is referred to as the "face side" (Fig. 99), and is the initial basis for measurement and testing. The planes commonly used for surfacing are the jack and the smooth planes. (See Units 11 and 12 for grinding and whetting plane irons for different purposes.)

Tools: Smooth or jack plane; try-square; two rules (straight-edges).

Material: Stock to be planed (surfaced).

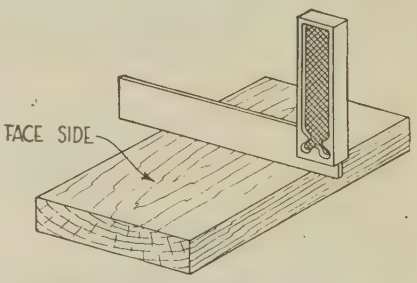


Fig. 99. The first side planed true and smooth is called the "face side." The try-square is frequently used for testing

PROCEDURE:

1. Select the Surface (face side)

Choose the better of the two faces. Select, if possible, one that is free from defects, such as wormholes and knot holes, splits or checks, heart center, warp and wind. This side is referred to as the "face side." It is usually the one exposed in a project. Inspect the surface carefully to discover any imperfections, and test for warp and wind.

2. Test for Warp and Wind

When the opposite arrises on the surface of a board are parallel but curved, the board is said to have warp; that is, the board is cupped.

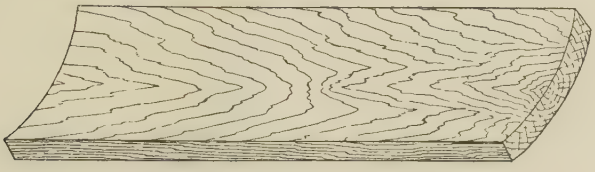


Fig. 100. A warped board

(Fig. 100.) When the face of the board is in a twist, that is, the opposite edges are not parallel, the board is said to be in "wind." Practically all lumber is warped or twisted more or less, and it is well to test for these defects. Green lumber is more liable to warp than dry or seasoned lumber, due to the unequal drying of the surfaces. After stock has been squared to dimensions, it should be protected. It should be piled so that all surfaces are either exposed or all covered to insure equal drying, and it must be kept away from radiators or steam pipes. Sometimes it is well to clamp several pieces together until they can be placed in the construction. The expert detects warp and wind by simply sighting along the surface. The beginner should detect warp and wind with a straightedge or try-square. (Fig. 101.) Hold the

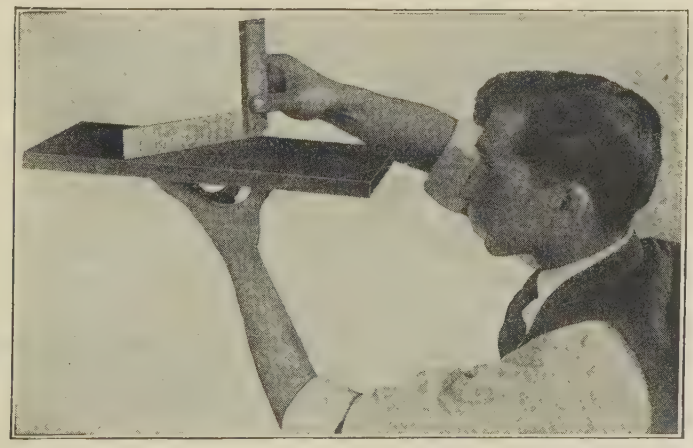


Fig. 101. Method of sighting when testing a surface. Shift the try-square to different positions

straightedge parallel to the edge, at right angles to the edge, and across both diagonals. See that the straightedge or try-square comes in contact with the stock at all points, so that the surface will be straight and true. Two straightedges, placed as in Figure 102, will indicate wind when their edges are not parallel. It is well to use one of the straightedge methods to detect slight wind. Reject any piece of stock that will not give the required thickness when warp and wind are removed by planing.

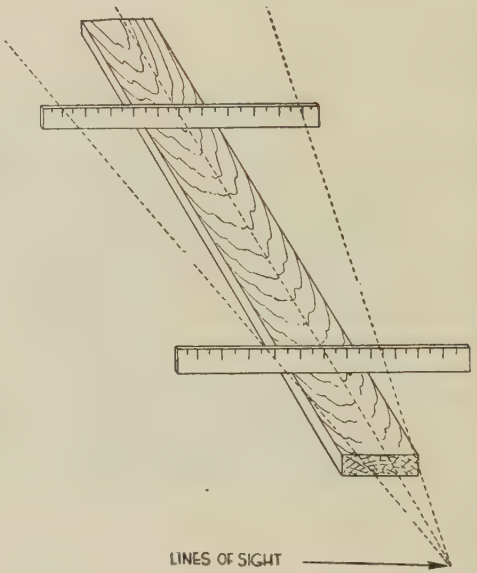


Fig. 102. Method of testing a surface for wind

3. Select, Assemble, and Adjust the Plane

The jack plane is commonly used where only one plane is available. The cutting edge of such a plane iron should be ground straight across with the corners rounded off. (Fig. 83, B.) Where two planes are available, each can be ground and used for a particular purpose. The jack plane is used for the rough surfacing and the cutting edge should be convex. (Fig. 83, A.) The long bed of the jack plane will not follow the small irregularities in the surface of the board, and a truer surface can be produced. The smooth plane, which is shorter, is used for fine surfacing, and the cutting edge should also be ground as in B, Figure 83. For average work the cap iron should be set about 1/32 in. from the cutting edge, and for fine work it should be set back only 1/64 in. The plane iron should be very sharp to produce a smooth surface. Use extreme care not to injure the cutting edge when adjusting the cap iron. It is important that careful lateral adjustment be made. If the corners of the plane iron extend too far through the mouth of the plane, ridges will be formed in the surface of the stock. A plane iron with a slight convex edge about the thickness of newspaper will produce a satisfactory surface without noticeable channels.

4. Clamp or Support the Stock

Boards must be held securely while planing. Fasten with the vise and bench stop, or place one end against the bench stop. (Figs. 98 and 103.)

5. Plane the Surface

When possible, always plane with the grain in the uphill direction with the fibers. (Fig. 103.) This will give a smooth surface, while attempting to plane against the grain will give a rough surface. In

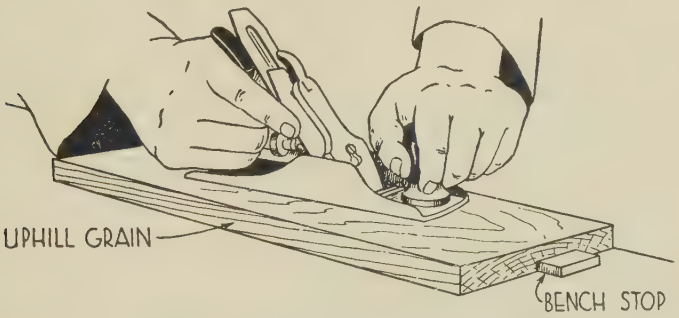


Fig. 103. Plane with the grain in the uphill direction whenever possible

irregular grain, it may be necessary to plane in one direction at one end of a board, and in the opposite direction at the other end. In starting the stroke, place the pressure on the knob. (Fig. 104.) When the toe and the heel of the plane are in contact with the stock, apply pressure equally on the knob and handle. At the end of the stroke, apply pressure

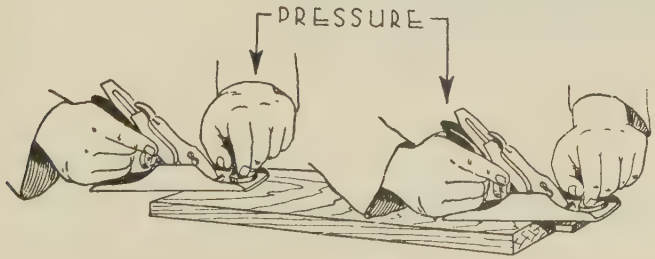


Fig. 104. Place the pressure on the knob at the beginning of the stroke, and on the handle at the end of the stroke, as indicated by the arrows

to the handle. If the stock is straight grained, the plane should be held parallel to the edge, taking cuts the entire length of the piece. However, on cross-grained stock, it is advisable to hold the plane at a slight angle, and allow it to creep, as in Figure 98. This will produce a shearing cut and a smoother surface. In planing a surface, the condition of it will determine the position in which the plane should be held, and also the direction of the stroke. When the stock has warp or wind, it is necessary

to shift the plane into different positions to insure a true surface. When the surface is very irregular, it may be advisable to cross-plane first and then finish with the grain. At all times, have as much of the plane bottom as possible in contact with the stock. Test the surface frequently with a try-square or a straightedge, as in Figure 101.

QUESTIONS:

1. Why is a surface planed?
2. What is a true surface?
3. To what is the term "face side" applied?
4. What planes are used in surfacing?
5. List the defects to be noted in selecting the face side.
6. What is (*a*) warp; (*b*) wind?
7. How do you detect (*a*) warp; (*b*) wind?
8. When the jack plane only is used for surfacing, how should the plane iron be ground?
9. How should the plane iron be ground for rough surfacing?
10. Why do you plane in the uphill direction with the grain?
11. In planing, where is the pressure placed (*a*) in starting the stroke; (*b*) in finishing the stroke?
12. What is meant by cross-planing?
13. What determines the direction of the stroke in planing?

UNIT 14

TO PLANE (JOINT) AN EDGE

Edges are planed to make them smooth and straight and for making joints. When an edge is planed true and at right angles to a face or surface, it is said to be "jointed." (Fig. 105.) This term is used since two edges so planed will make a good joint. The edge which is jointed first is called the "joint edge." It is also the basis for measurement in squaring up stock. A special plane with the plane iron ground perfectly straight is used for jointing where accurate work is essential. The jointer plane is longer than the other planes. (Unit 10.)

Tools: Rule; pencil; marking gauge; jack or jointer plane; try-square.

Material: Stock to be jointed.

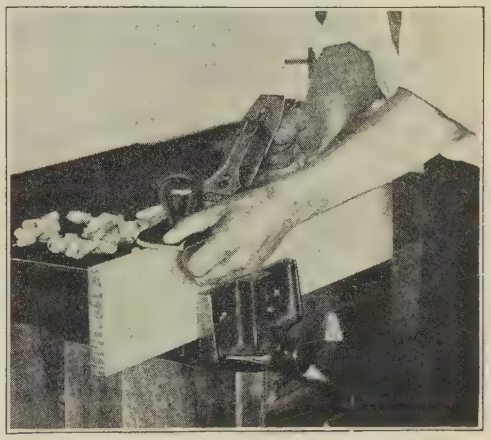


Fig. 105. Jointing an edge

PROCEDURE:

1. Select the Edge to be Planed (Jointed)

Two edges of a piece of stock usually present themselves for planing. Select the better of the two edges for jointing first. Note any defects that would interfere with the jointed edge.

Fig. 106. A long jointer plane will produce a truer edge in jointing

2. Assemble and Adjust the Plane

It is easier to plane a long edge straight with a long plane than with a short one. A long plane bridges the low spots and does not cut

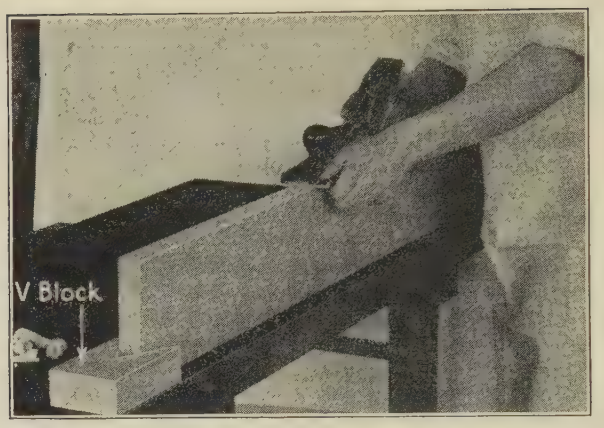


Fig. 107. A V block used to support long pieces when jointing

them until the high parts are removed. (Fig. 106.) Select a jointer plane for long edges. A jack plane will joint short edges successfully. A fore plane is sometimes used in jointing. In length it is between the jack and the jointer plane. The cutting edge of the plane iron should be ground perfectly straight (Fig. 83, C), for jointing edges that are to be glued.

3. Clamp the Stock

Clamp the stock securely in the vise. The stock must be held rigidly. This will make it easier to produce an accurate jointed edge. The carpenter often uses a V block (frog) to support long pieces when jointing on top of the bench. (Fig. 107.) A hand screw will aid in supporting the end of a wide piece when jointing. (Fig. 227.)

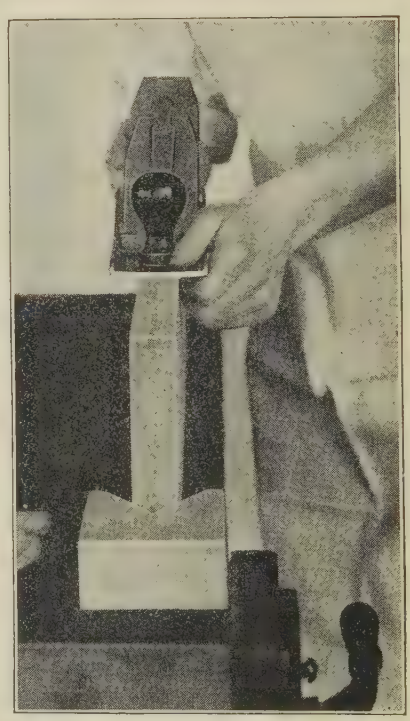


Fig. 108. Hold the plane parallel with the edge when jointing

4. Joint the Edge

Hold the plane parallel with the edge, as in Figure 108. It is especially important in jointing to apply pressure on the toe of the

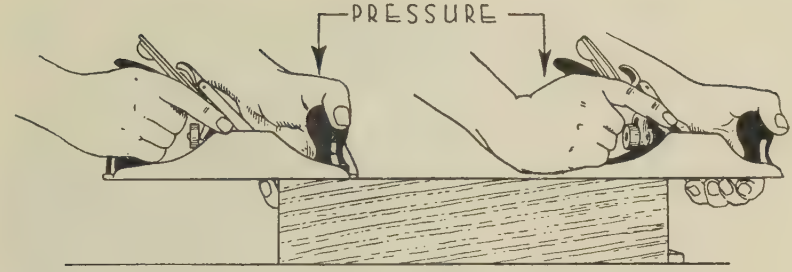


Fig. 109. Place the pressure on the knob at the beginning of the stroke, and on the handle at the end of the stroke as indicated by the arrows

plane at the beginning of the stroke and on the heel at the end of the stroke. (Fig. 109.) Plane until uniform shavings are removed from the entire length of the piece. Make this edge square with the better face (called "face side") of the board. (Fig. 110.) Test at different places along the entire edge as in Figure 111. Hold the beam of the try-square firmly against the face as each test is made. Rejoint the edge if any irregularity is noted.

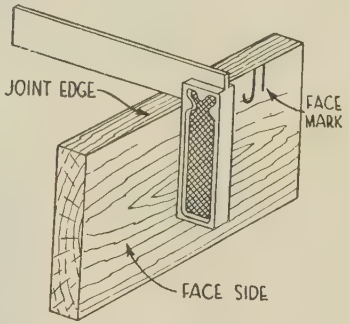


Fig. 110. The "joint edge" is made square with the "face side." Note the face mark

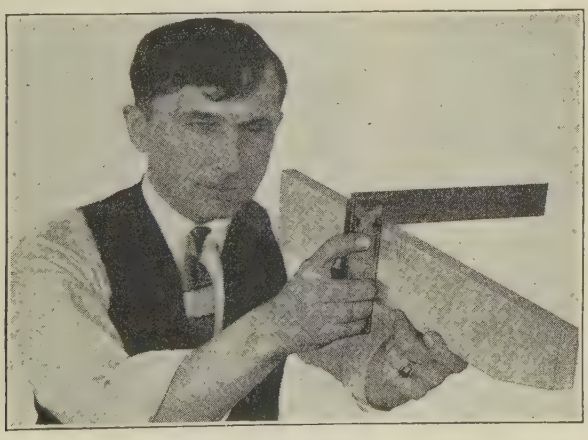


Fig. 111. Using the try-square to test a jointed edge

5. Mark the Face Side

In order to locate the face side and the joint edge, the face side is marked at its junction with the joint edge. Note the face mark in Figure 110, which is characteristic of the many symbols used. A mark at this arris is all that is necessary to designate these two surfaces. All later squaring, gauging, and measuring is done from the face side or the joint edge.

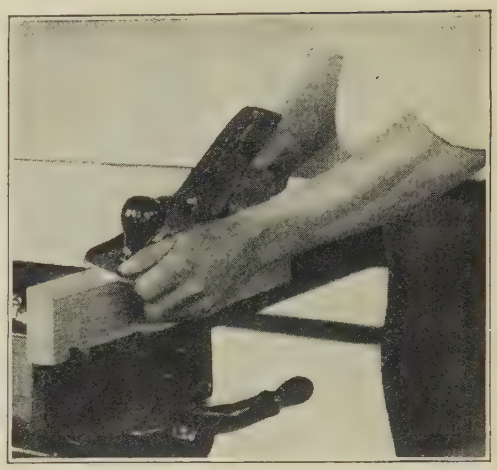


Fig. 112. Beveling an edge

6. Bevel an Edge

The customary jointed edge is at right angles to the face of the board. Such an edge, not at right angles, is called a bevel. The bevel often is used in construction. In carpentry, boards are often beveled for water drainage. In furniture making, the bevel is often used to improve the appearance where it is necessary to break the effect of too many right angles. The usual method of beveling is: joint the edge, pencil gauge for the amount of the bevel on one side, and then plane to the gauge line. (Fig. 112.) The T bevel may be used for testing the angle and the uniformity of the bevel. (Fig. 113.)

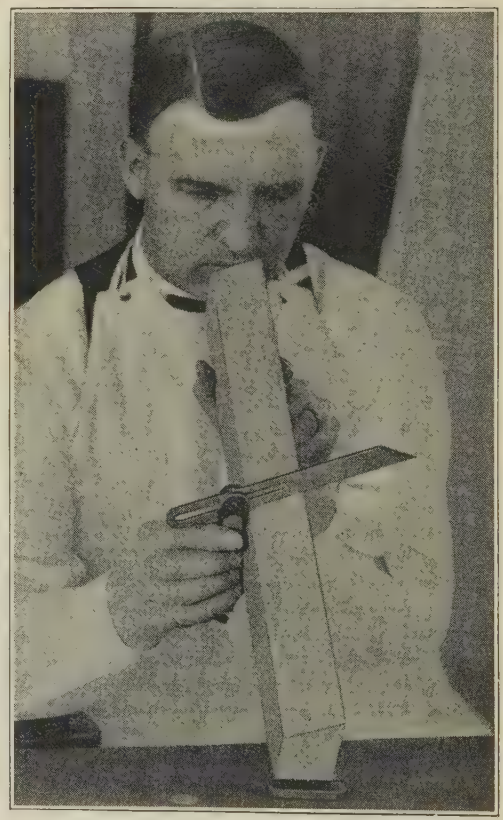


Fig. 113. Testing a bevel with a sliding T bevel

QUESTIONS:

1. What is a jointed edge?
2. Account for the name "jointed edge."
3. Why should a jointed edge be very accurate?
4. What special plane is used in jointing?
5. How long is this plane?
6. How should the plane iron be ground for jointing?
7. What is the advantage of using a long plane in jointing?
8. When can a jack plane be used for jointing?
9. What is the use of a fore plane?
10. Why should the piece be clamped securely when jointing an edge?
11. How does the carpenter fasten long stock when jointing?
12. How may a wide piece be supported when jointing?
13. How is the plane held when jointing?
14. What would be the cause of rounding the ends in jointing?
15. The jointed edge is tested for squareness with what face?
16. Why should the last shaving be the entire length and width of the edge?
17. What tool is commonly used to test the squareness of the joint edge?
18. What is a bevel?
19. Give the procedure in planing a bevel?
20. What tool may be used to test the bevel?

UNIT 15

TO PLANE END GRAIN

End grain is planed to smooth a surface that has been left rough by sawing. This is done when the surface is exposed in the project. (Fig. 114.) End grain is also planed to square an end or fit a joint where the sawing has been inaccurate. Accurate sawing will often eliminate un-

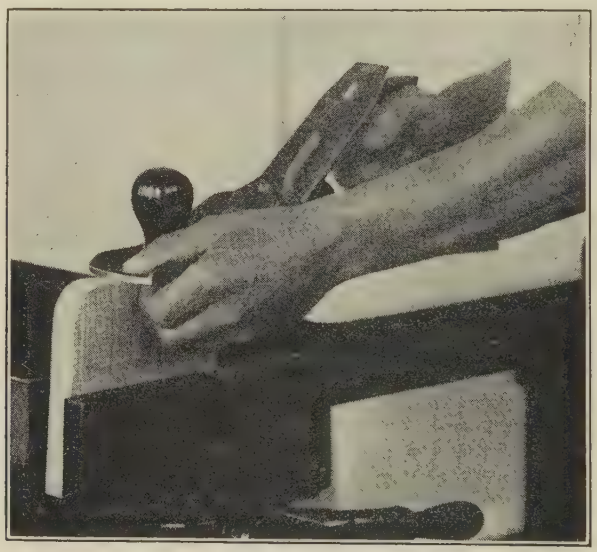


Fig. 114. End planing the top of a bookrack end

necessary end planing. The shorter planes are ordinarily used for end planing. End planing is more difficult than surfacing or jointing, because the fibers of the wood must be cut off across the grain. A sharp tool is essential.

Tools: Smooth or jack plane; block plane; try-square.

Material: Stock to be end planed.

PROCEDURE:

1. Select the End

Select the better of the two ends for the first planing.

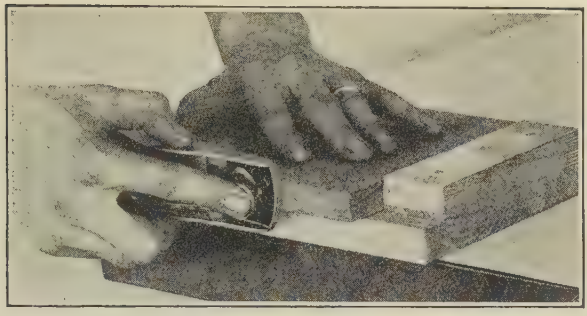


Fig. 115. Planing the end of a board on a bench hook with a block plane

2. Select, Assemble, and Adjust the Plane

Use a smooth or jack plane if the stock is held in the vise. Where it is inconvenient to bring the stock to the vise, or where a vise is not available, a block plane is often used. Figure 115 shows the block plane in use on the bench hook.

The plane iron should be ground to a straight edge. A plane iron with a straight edge and rounded corners will tend to eliminate plane marks particularly noticeable in end grain. See Figure 83 for different forms of cutting edges. The plane iron should be exceptionally sharp to cut off the fibers smoothly. Grind the edge to suit, and whet to a keen edge before attempting to plane. Adjust the depth of the cut to take as thin a shaving as possible.

Fig. 116. Method of holding a window sash or other frame when planing the end

3. Clamp the Stock

Clamp the stock low in the vise to eliminate vibration, or hold securely on the bench hook, since it requires considerable force to cut

across the grain. Doors, window sash, and the like, are often held in place, as in Figure 116, for planing the end.

4. Plane the End

Plane from one edge and stop before the other edge is reached. (Fig. 117.) Gradually raise the heel of the plane just before the end of the stroke. This will feather the shaving so that no plane mark will be left. Reverse and plane from the other edge, feathering and stopping as before. On pieces less than 8 in. wide, feathering is impractical and the plane should be held flat to the surface. An extremely thin shaving will aid in eliminating plane marks. Planing all the way across the end may split off the corner. (Fig. 118.) If the edges are chamfered or rounded, the tendency to split off the corners will be reduced. (Fig. 114.) In this case planing entirely across the end may be successful. Often a temporary chamfer is made in the waste stock at the far corner to pre-

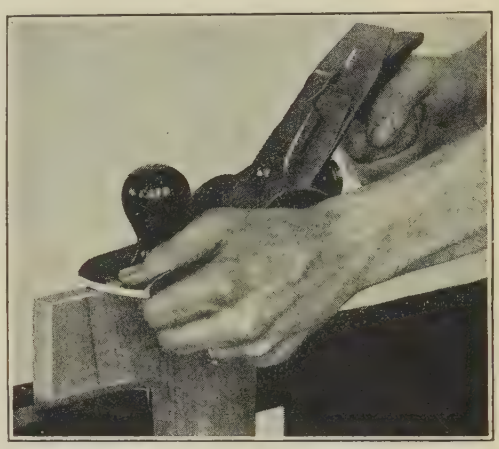


Fig. 117. Plane from one edge and stop before the other edge is reached

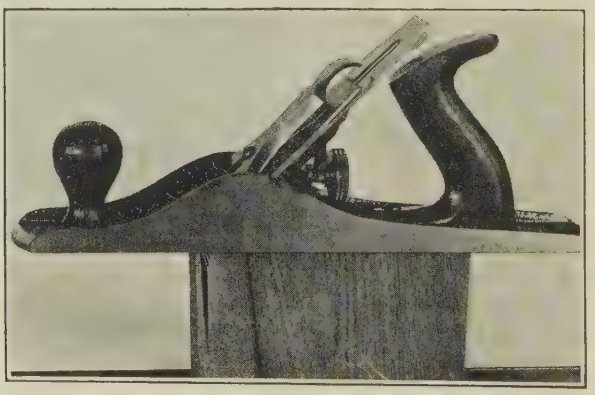


Fig. 118. Planing all the way across may split the piece

vent splitting when planing all the way across is desired. In the case of very narrow pieces, a block is clamped behind the stock to prevent splitting.

On the last stroke, produce a uniform and smooth surface, if possible. Extreme care here will help to prevent plane marks which will be more plainly seen after the finish (stain, varnish, etc.) is applied. If the planed end is to be square with the face side and joint edge, test with the try-square as indicated in Figures 119 and 120.

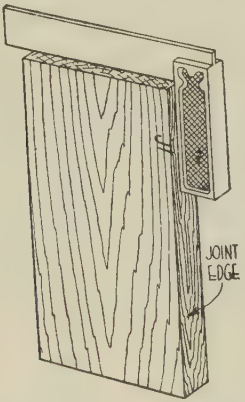


Fig. 119. Test the end from the "joint edge"

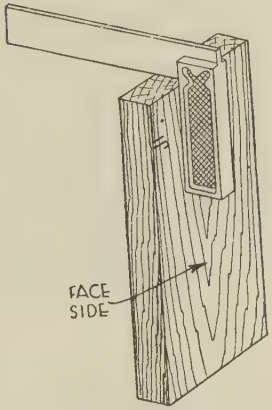


Fig. 120. Test the end from the "face side"

QUESTIONS:

1. Give two reasons for planing end grain.
2. What planes are used for end planing?
3. Why is end planing difficult?
4. Why should the plane iron be exceptionally sharp for end planing?
5. How should the cutting edge of the plane iron be ground for end planing?
6. What should be the depth of the cut for end planing? Why?
7. How should stock be clamped in the vise for end planing?
8. When is the block plane used?
9. Why not plane entirely across the end?
10. Why do you feather the shaving?
11. What could you do, so that you might plane entirely across the end?
12. Name two methods used to prevent splitting when planing end grain.
13. What edge and side do you use for testing an end for squareness?

UNIT 16

TO PLANE A THROUGH CHAMFER

Chamfering is the process of removing the sharp arrises from a piece of stock. This is often done for appearance as well as to remove a sharp arris or corner that might cause discomfort or injury. When

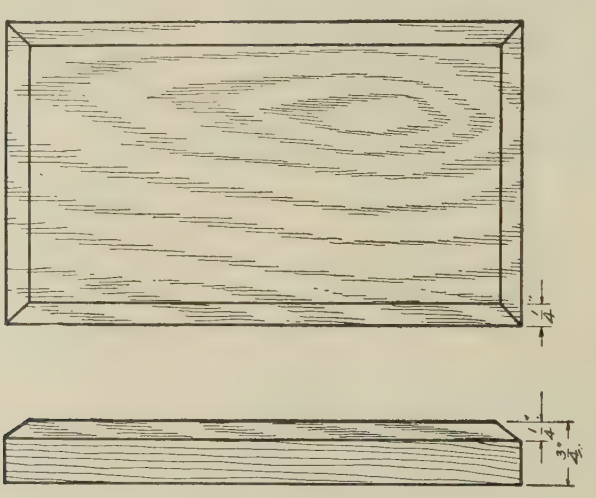


Fig. 121. Detail of a through chamfer on a mounting board

the entire arris is removed, it is called a "through" chamfer. (Fig. 121.) The usual chamfer is 45 degrees. The process involves planing with and across the grain. The jack plane is commonly used in chamfering. Figure 122 shows a chamfered edge in contrast to a jointed edge and beveled edge.

Tools: Rule; pencil; jack or jointer plane; T bevel.
Material: Stock to be chamfered.

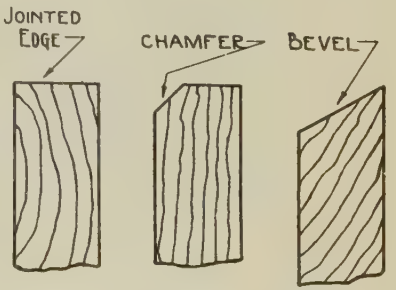


Fig. 122. Chamfered edge shown in contrast to a jointed edge and a beveled edge

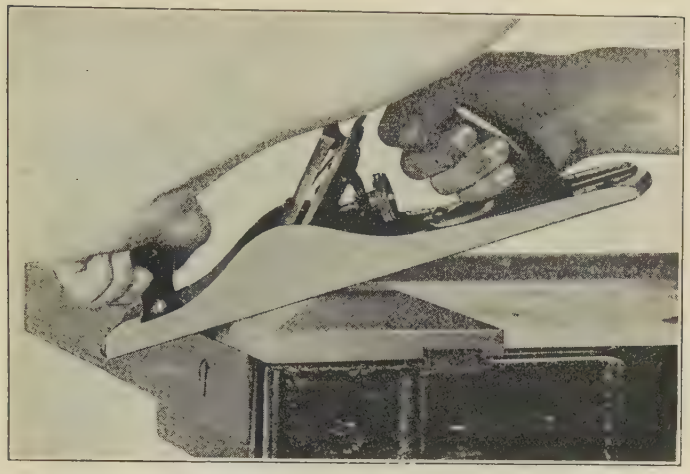


Fig. 123. Planing an oblique chamfer

PROCEDURE:

1. Gauge for the Chamfer

Note the dimensions of the chamfer in the drawing. To lay out a 45-degree chamfer, gauge equal distances from the arris on both surfaces. A common amount to gauge for such a chamfer on ¾-in. stock is 3/16 to ¼ in. For oblique chamfers (Fig. 123) lay out unequal distances. The larger distance is usually laid out on the face.

Lay out the lines for all chamfers with a pencil. If a marking gauge is used, substitute a pencil for the pin. Otherwise, pencil gauge as in Figure 124.

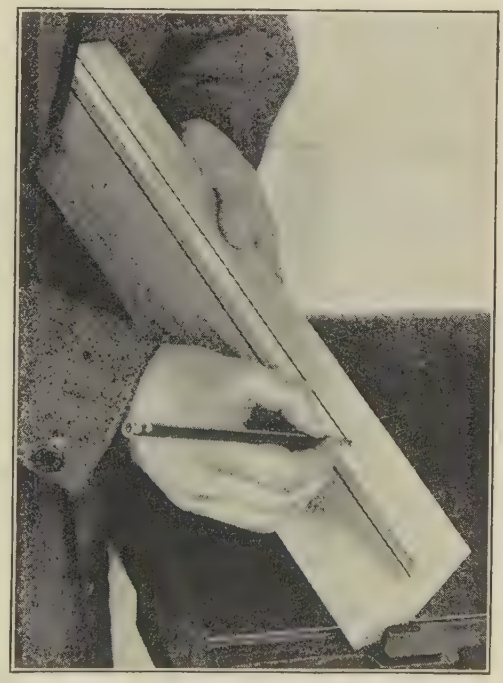


Fig. 124. Pencil gauging for a chamfer

2. Chamfer With the Grain

Clamp the piece securely, tilt the plane, and plane with the grain

as in jointing an edge. (Fig. 125.) Plane down to the chamfer lines on the last cut. Test with a T bevel. (Fig. 126.)

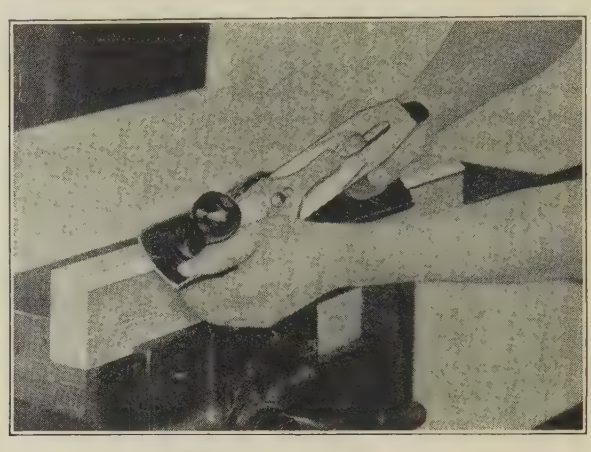


Fig. 125. Chamfering with the grain

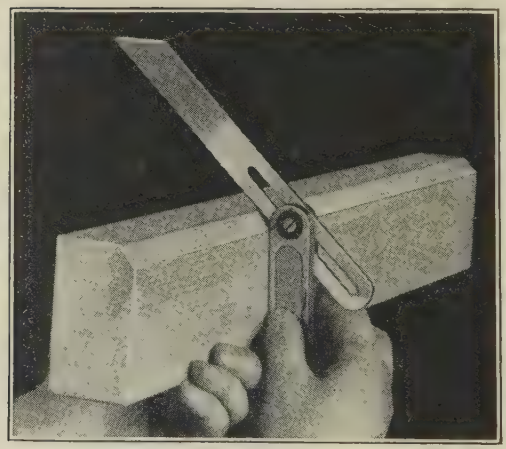


Fig. 126. Testing a chamfer with a sliding T bevel

3. Chamfer the End Grain

Clamp the stock in the vise and hold the plane at an angle as in Figure 127. Attempt to plane down to both lines on the last cut, and check with a T bevel set at the proper angle. Figure 128 shows the method of chamfering the end grain of a leg.

Fig. 127. Hold the plane at an angle when chamfering end grain

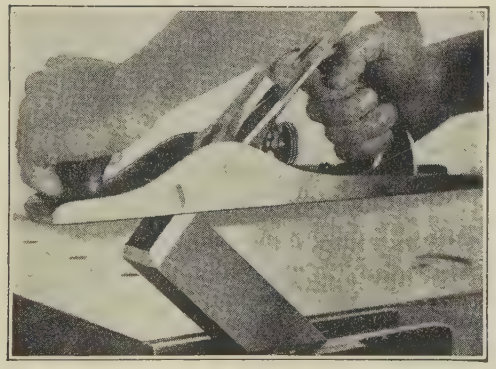


Fig. 128. Chamfering the end grain of a leg

QUESTIONS:

1. What is chamfering?
2. What is the use of chamfering?
3. What is a through chamfer?
4. What is the usual angle of a chamfer?
5. What is the difference between a chamfer and a bevel?
6. How is a chamfer of 45 degrees laid out?
7. When is a chamfer oblique?
8. With what must all chamfers be laid out?
9. What would be the objection to laying out chamfers with the pin of a marking gauge?
10. What tool will check the accuracy of a chamfer?

UNIT 17

TO SCRAPE A SURFACE

A surface can be made smooth with a scraper when irregular direction of the grain prevents successful planing. This is especially true of hard woods, or soft woods containing many knots, such as red cedar.

Fig. 129. Scraping a surface with a cabinet scraper

The cutting principle of the plane blade and the scraper is identical, but because of the turned edge on the scraper, the shavings are broken more often and more abruptly, thus producing a smoother surface. The two scrapers used, are the hand and the cabinet scraper. The hand scraper is a flat piece of steel about 3 by 5 in. It is used for smoothing the parts of surfaces which cannot be reached with the cabinet scraper. The cabinet scraper (Fig. 129) consists of a metal frame which holds the blade rigidly and at the proper angle. An adjusting screw allows the depth of the cut to be

Fig. 130. File the flat side of the blade to remove the old edge

regulated. Because of the fine turned edge, the scraper must be sharpened frequently while using. It is usually necessary to sharpen a scraper before using.

Tools: Cabinet scraper (holder and blade); hand scraper; mill file; vise; burnisher; oilstone; oil.

Material: Stock to be scraped.

Fig. 131. File the beveled side of the blade to sharpen it

PROCEDURE A: Scrape with a Cabinet Scraper

1. **Remove blade from holder**
2. **Remove old turned edge (Fig. 130)**

Clamp the blade in the vise, and with the file held flat on the straight side of the blade, remove the old edge. A couple of strokes are sufficient.

3. File to a keen edge (Fig. 131)

Use a continuous stroke, sliding the file horizontally from one edge to the other as you push forward. Produce a bevel of about 45 degrees. Remove the wire edge, if necessary, as in step 2. Use light pressure on the last strokes to produce a keen edge. The scraper is sometimes ground to produce the edge. However, grinding is more difficult and usually takes longer.

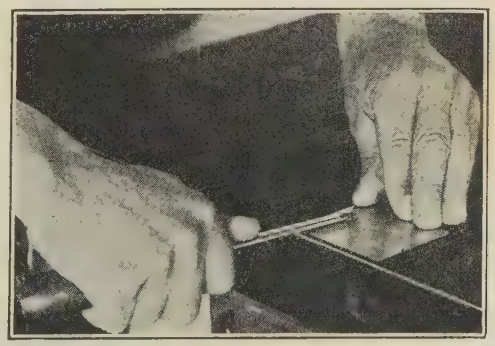


Fig. 132. Burnishing the unbeveled side of a cabinet-scraper blade

4. Whet the edge

This step may be omitted for rough work. Better results are secured for the finishing touches if the blade is whetted to a keen edge. Refer to Unit 12 for the directions for whetting.

5. Draw and turn over the edge (burnish)

After the edge has been filed sharp, or it has been whetted, place it on the bench with the unbeveled side up (Fig. 132), and stroke once or twice with a burnisher, holding it flat to the blade. This tends to draw the edge (Fig. 138) and make it smooth. Place the blade in a vise, as in Figure 133*a*, and stroke with a burnisher, commencing at one end

and continuing the entire width. Three strokes are usually enough; more may turn the edge too much. Do not bear on the blade too hard on the first stroke, but increase pressure in the following strokes. Start with the burnisher slightly above the bevel on the first stroke. (Fig. 133*b*.) Gradually raise the handle of the burnisher, until it is about 15 degrees below a horizontal on the finishing stroke. The edges can be renewed several times by burnishing. If no burnisher is available, use a nail set, a gouge, or any piece of tempered round steel.

Fig. 133*a*. Burnishing the beveled side of a cabinet-scraper blade

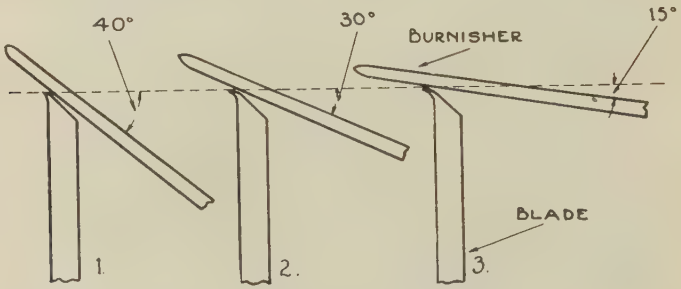


Fig. 133*b*. Steps showing angles for the different strokes in burnishing a cabinet-scraper blade

6. Assemble

Insert the blade in the holder from the bottom. Place the bevel side of the blade toward the adjusting thumbscrew on the holder. Make sure that the adjusting screw is loose. Let the bottom of the holder and the cutting edge of the blade rest on a flat surface, and tighten the thumbscrews to hold the blade securely in place.

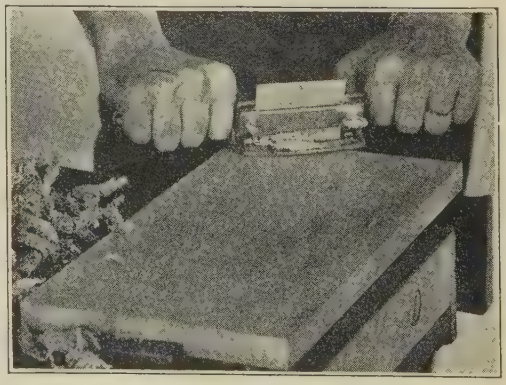


Fig. 134. Position of the cabinet scraper when working near the end

7. Adjust and Use

Turn the adjustable thumbscrew until it touches the blade. Try it on the stock to be scraped, and regulate the desired cut. Hold the scraper

at an angle to produce a shearing cut. Push it from you, working parallel with the grain. Where only a portion of a surface needs scraping, feather the shaving as in planing by gradually raising the heel of the scraper at the end of the stroke. In working near the end, note the position of the scraper in Figure 134. When the scraper fails to cut a *shaving*, it is not working properly and should be resharpened.

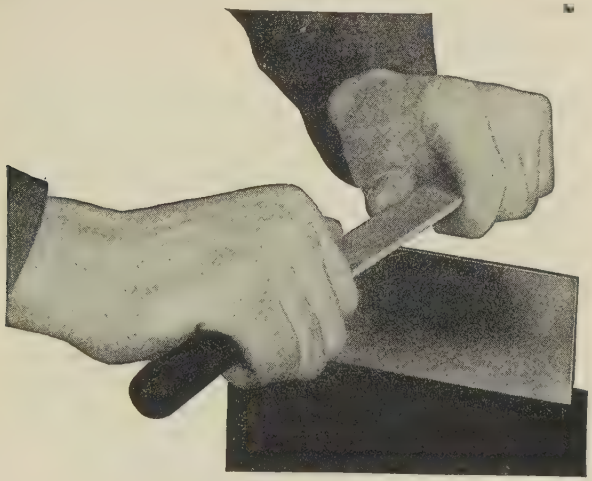


Fig. 135. Drawfiling a hand-scraper blade

PROCEDURE B: Scrape with a Hand Scraper

1. Re-Form the Edge

Grind or file the edge, making it straight and square with the faces. For filing, clamp the blade in the vise, and drawfile the edge,

Fig. 136. Whetting the edge of a hand scraper after filing or grinding

as in Figure 135. Hold the file in both hands and at right angles to the faces as you drawfile. File along the entire edge with a continuous stroke. File only on the forward stroke. Rounding the sharp corners slightly will prevent them from digging in while scraping.

2. Whet the Edge

A sharper edge is obtained by whetting. This is secured by rubbing on a whetstone. Hold the scraper upright, and rub back and forth as

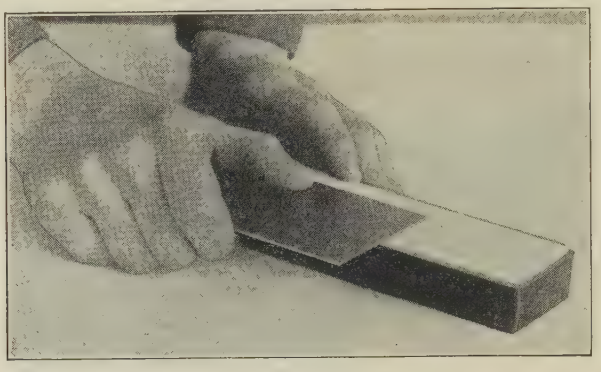


Fig. 137. Hold the scraper blade flat on the stone to remove the wire edge

in Figure 136. Remove the burr by placing the blade flat on the stone (Fig. 137), and rubbing as before. Reverse the blade, and remove the burr from the other edge.

3. Draw the Edge (Burnish)

Draw one edge on the face side similar to the method used for a cabinet-scraper blade. (Fig. 132.) Apply considerable pressure, and stroke once or twice with the burnisher, holding the burnisher flat to

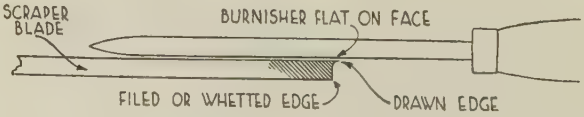


Fig. 138. Showing the method of producing a drawn edge

the blade. This will draw the edge and make it smooth. (Fig. 138.) Burnish the other edge likewise.

4. Turn the Edge (Burnish)

Hold the blade rigidly and perpendicular to the bench. (Fig. 139.) Allow the edge being burnished to project over the edge of the bench. Burnish the edge lengthwise with a drawing motion to turn the edge

out. Turn the burnisher back about 5 degrees from the perpendicular. (Fig. 140.) Two or three strokes should turn the edge, if sufficient pressure is applied. Reverse the blade, and burnish the other edge in a similar manner. Some desire to place the scraper flat on the edge of the bench or clamp in the vise while turning the edge. In either case, hold the burnisher at the proper angle, and turn the edges out.

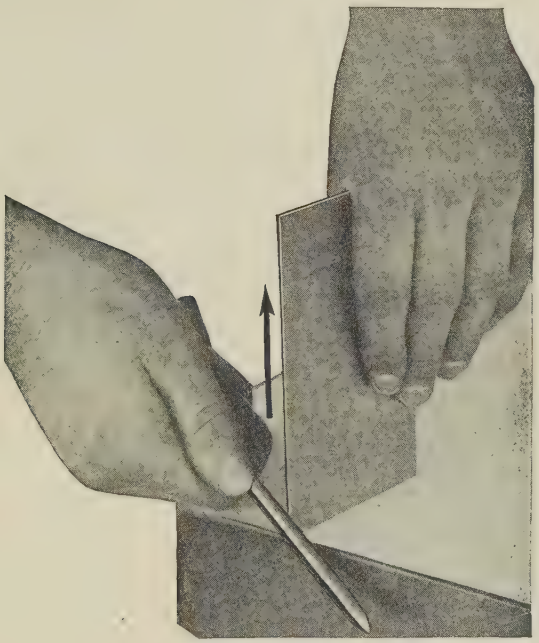


Fig. 139. Burnishing a hand scraper. Arrow shows direction of stroke

5. Scrape the Surface

A hand scraper can be either pulled or pushed. Grasp the blade with both hands and hold it at an angle of about 70 degrees. Apply pressure as the stroke is made. Figure 141 shows the scraper being pulled. The edge should cut easily and produce a very thin shaving.

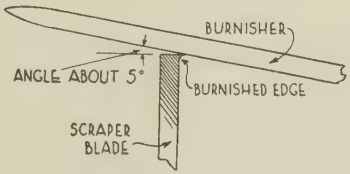


Fig. 140. Showing the method of burnishing or turning the edge of a hand scraper

Re-burnish, or re-form the edge and burnish, just as often as the scraper fails to work properly.

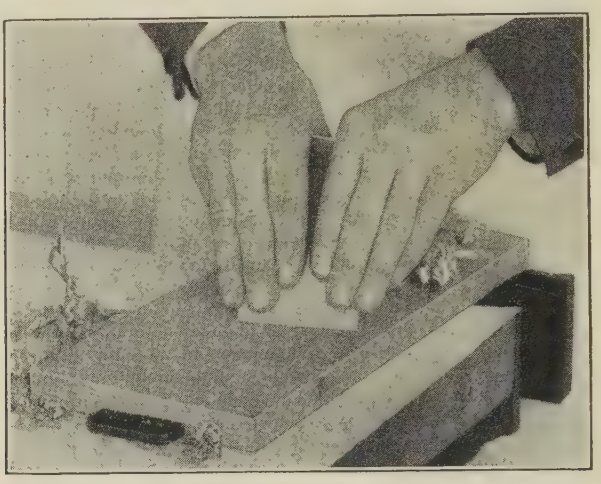


Fig. 141. Method of holding a hand scraper when blade is pulled toward the operator

QUESTIONS:

1. When is a scraper used to smooth a surface?
2. What is the advantage of scraping in comparison to planing?
3. Name the two scrapers commonly used.
4. When do you use a hand scraper?
5. What are the advantages of a hand scraper?
6. What are the advantages of a cabinet scraper?
7. Why must a scraper be sharpened frequently?
8. How is the old edge removed?
9. How can the new edge be formed?
10. Why do you whet the edge?
11. What is a burnisher?
12. Why is the edge of the blade turned over?
13. Why is the scraper held at an angle while scraping?
14. Can a scraper be resharpened by reburnishing?
15. Why round the corners of a hand scraper?
16. How does the sharpening of a hand scraper differ from a cabinet scraper?

UNIT 18

TO SAND AN UNFINISHED SURFACE

Sanding is the final operation in smoothing an unfinished surface. (Fig. 142.) The surface should be properly planed and scraped, and all operations performed with edge tools should be completed before sanding is begun. This will prevent the dulling of edge tools by the sand dust. After sanding, a surface should be uniformly smooth and ready for the application of the finish. Sandpaper is furnished in different grades. The size of the sheet is about 9 by 11 in. The common numbers ranging from fine to coarse are: 2/0, 0, ½, 1, 1½, and 2. Finer and coarser grades are also available. Two sizes of garnet paper, most suited for average work, are 2/0 and ½.

Some good rules for sandpapering are:

1. Always sand with the grain whenever possible.
2. Never use sandpaper to attempt to do the work of an edge tool.
3. Do not sand surfaces that are to be joined.
4. Do not work carelessly and expect sandpapering to remedy the defects from edge-tool operations.

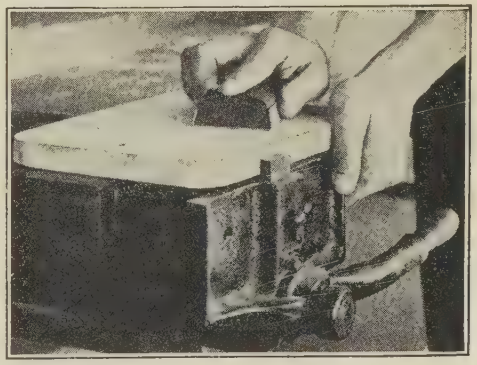


Fig. 142. Use a sandpaper block for sanding flat surfaces

Tools: Sandpaper; sandpaper block.

Material: Stock to be sandpapered.

PROCEDURE:

1. Select the Proper Grade of Sandpaper

For the first sanding use the coarser grades of sandpaper. If the surface has been properly smoothed with a plane or scraper, size ½ garnet paper generally is used. Rougher surfaces require the use of coarser grades. Continue the sanding by selecting the finer grades in order. Number 1/0 usually produces a satisfactory surface for the application of a finish.

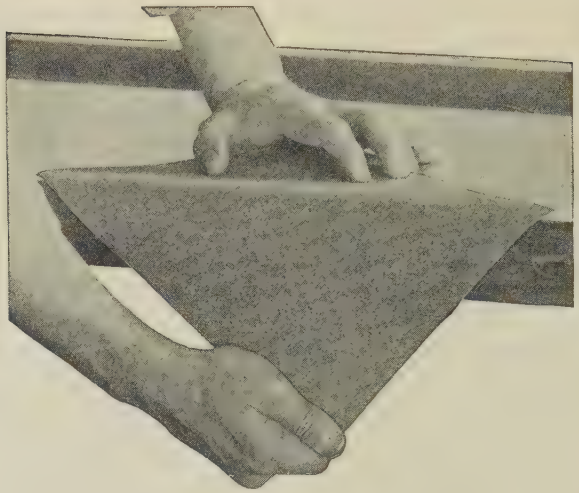


Fig. 143. Limbering sandpaper to make it more pliable

2. Limber the Sandpaper

Limber the sandpaper by drawing it across the arris of the bench, as indicated in Figure 143. A new sheet of sandpaper is quite rigid. The limbering process will make it more pliable and help to prevent cracking.

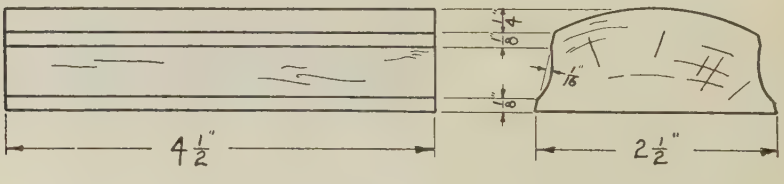


Fig. 144. A properly dimensioned sand block is much better than a scrap piece of stock

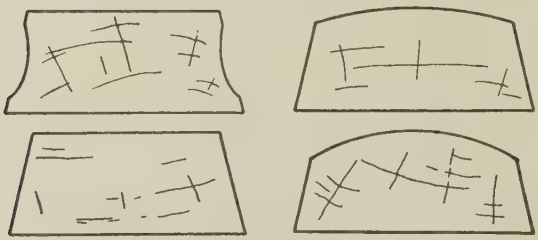


Fig. 145. Suggested end views for different sand-block construction

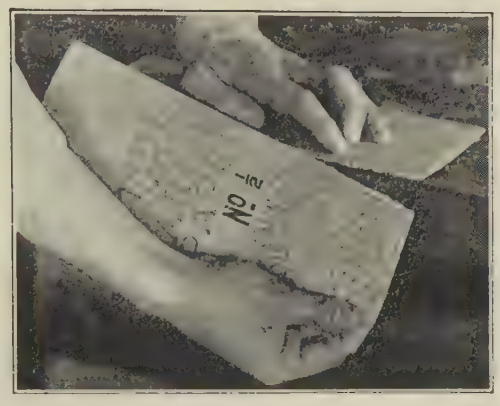


Fig. 146. Tearing sandpaper on the arris of a bench

Fig. 147. Tearing sandpaper with a handsaw

3. Tear the Sandpaper

A sheet of sandpaper should be torn into either four or six pieces. Figure 144 shows a sandpaper block properly dimensioned for one sixth of a sheet. This is a convenient size for general use. To tear a sheet of sandpaper, fold it with the sanded side in. Tear with a quick movement over a sharp arris, as in Figure 146. Sandpaper is sometimes torn with a saw or straightedge. In this case, place the sanded side of the paper on the bench, and tear as in Figure 147.

Fig. 148. Method of holding block flat when sanding an edge or an end

4. Select the Block and Fit the Sandpaper

Select or make a sandpaper block (Fig. 144) to fit the size of the paper. A regular sandpaper block with the paper fitted tightly over its base is recommended rather than the use of scrap pieces of stock. Using a block will give a truer surface.

5. Sand the Surface

Hold the paper with the thumb and fingers as indicated in Figure 142. Sand with the grain to prevent scratches that would show on the finished project. Keep the block flat on the surface. Apply pressure, and rub back and forth until the surface is uniformly s m o o t h. When sanding near an arris, take particular pains to hold the block flat. F i g u r e 148 shows a method of sanding an edge or an end. A f t e r sanding carefully with the coarser grades of paper, finish with the finer.

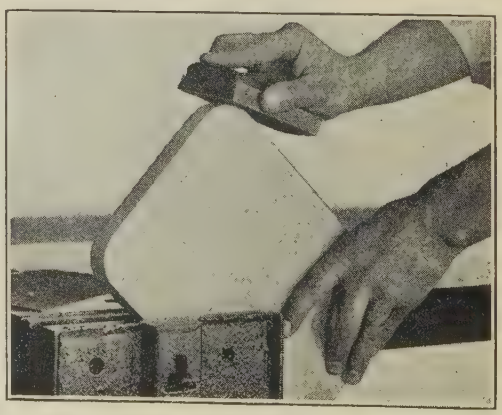


Fig. 149. Sanding a rounded corner

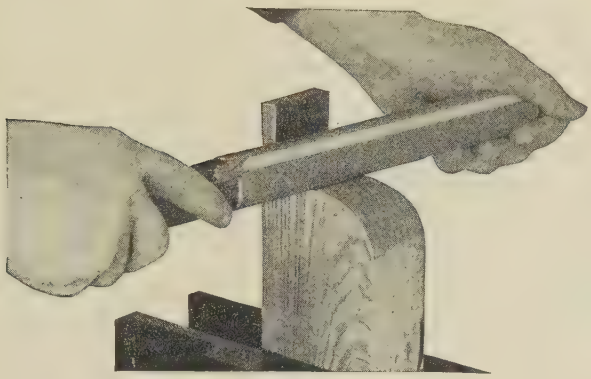


Fig. 150. Sandpaper fastened to a round rod is convenient for sanding concave surfaces

If it is desired to remove the sharp arrises, use a piece of fine sandpaper held in the hand. This operation is called "breaking the edges."

On curved surfaces use a block whenever possible. Figure 149 shows a flat block being used to smooth a rounded corner or convex curve. Sandpaper wrapped or fastened on a round rod is convenient for sanding concave curves. (Fig. 150.) The paper can be fastened to such a rod by plowing a groove and wedging the ends of the sandpaper in the groove with a strip of wood. If only a small amount of sanding is necessary, the paper may be wrapped around the rod and held in place with the fingers. Rods of different diameters are convenient for irregular curves. When a block will not conform to the shape of the curve, use the paper free in the hand. (Fig. 151.) When the sandpaper is to be held in the hand, fold it once with the sanded side out. This will prevent the paper from slipping in the fingers.

Fig. 151. Sandpaper can be used in the hand to smooth irregular curves

QUESTIONS:

1. Why is the operation of sanding performed?
2. What operations should be completed before sanding? Why?
3. What is sandpaper?
4. What is meant by the grades in sandpaper?
5. What is the object of the different grades in sandpaper?
6. What two grades of sandpaper are generally used?
7. State three good rules for sanding?
8. When do you use coarse sandpaper? When fine?
9. What is the size of a sheet of sandpaper?
10. Why limber a sheet of sandpaper?
11. How is sandpaper torn?
12. Should you cut sandpaper with a knife? Why?
13. Into how many parts should a sheet of sandpaper be divided?
14. What is a sandpaper block?
15. Why is a block recommended?
16. Why sand with the grain?
17. How should the block always be held when sanding a flat surface?
18. How would you sand a concave surface?

UNIT 19

TO LAY OUT VARIOUS FIGURES AND DESIGNS

A variety of designs for projects is desired by the woodworker. The appearance of every project is affected by the design of its parts. Some designs have become quite standardized and special methods have been developed for laying them out.

The hexagon, octagon, circle, and ellipse, are among the most common standard designs. The hexagon and octagon are used in the design of taborets, stands, stools, and tables. Where the straight-line effects are not desired, circles, ellipses, and irregular curves are used. Tops and mounting boards are often circular or elliptical. Parts of circles (arcs) and parts of ellipses are frequently used in irregular curves. (Fig. 152.) Irregular designs require the development of an individual pattern. These can be developed originally or copied from drawings. A method of laying out some of the standard designs is given in the following, as well as a method for copying irregular designs.

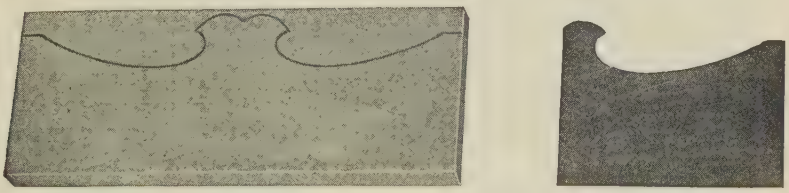


Fig. 152. A curved design and the pattern used to lay it out

Tools: Working drawings; pencil; rule; straightedge; dividers, or pencil compass; knife; string.

Materials: Cardboard or sheet metal for patterns; stock to be laid out.

PROCEDURE A: To Lay out with a Pattern (Template)

Designs or duplicate parts are often laid out with a pattern or template. (Fig. 153.) Patterns or templates are usually made from cardboard or sheet metal. Where several members of a project are alike, the first one made can be used as a pattern. (Fig. 154.) By using the same pattern, uniformity is secured. In laying out with a pattern,

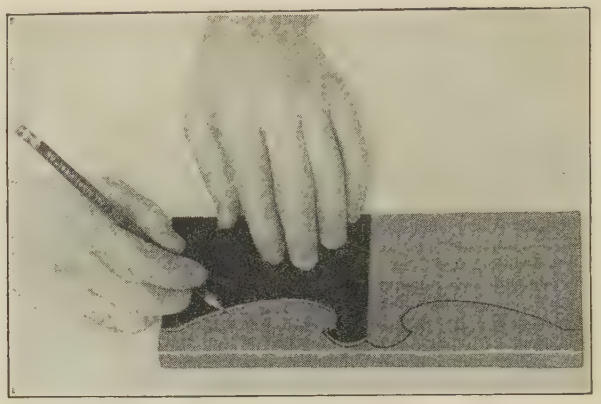


Fig. 153. Method of laying out a design

Fig. 154. Use a pattern where several legs, etc., are to be alike

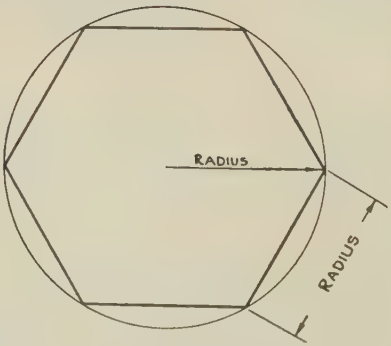


Fig. 155. Use the radius of the circle to lay out a hexagon

Fig. 156. Hexagon waste-paper basket

always hold it securely in place until all lines are drawn and points located. Use a sharp pencil or knife where accuracy is important.

PROCEDURE B: To Lay Out a Regular Hexagon

A regular hexagon is a figure of six equal sides and angles. Note the length of one side of the hexagon. Use this distance as the radius, and draw a circle with the dividers. (Fig. 155.) Step off the sides of the hexagon on the circumferences with the dividers still set at the length of the radius. The last point stepped off should coincide with the first. Draw lines to connect the points. Make a pattern, or lay out the hexagon directly on the board. See Figure 156 showing a waste-paper basket with a hexagon bottom.

PROCEDURE C: To Lay Out a Regular Octagon

A regular octagon is a figure of eight equal sides and angles. Draw a square with dimensions equal to the distance between any two parallel sides of the octagon. Measure the length of the diagonal.

Fig. 157. Method of laying out an octagon from a square

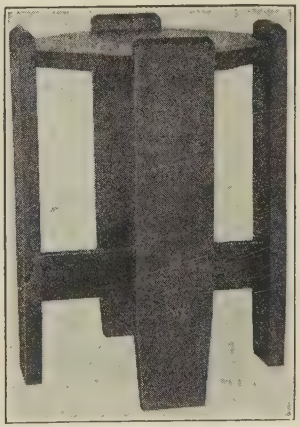


Fig. 158. A taboret with an octagon top

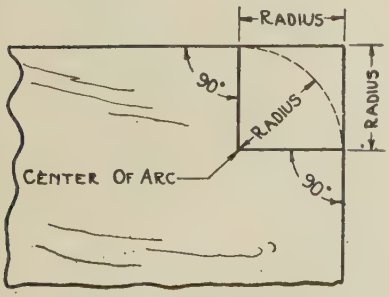


Fig. 159. Method of laying out a rounded corner

Take one half of the length of the diagonal and use this distance as the basis for laying out the octagon. Measure this distance (one half of the diagonal) from each corner in both directions. This will locate eight points. The dividers are sometimes used to lay off this distance and locate the eight

points. Connect these points to lay out the octagon as in Figure 157. A taboret, Figure 158, shows the use of the octagon in design.

PROCEDURE D: To Lay Out a Rounded Corner

Square up the stock, and note the radius of the rounded corner desired. Measure the distance of the radius from the corner. Do this along both edges. (Fig. 159.) The intersection of lines squared from these marks will be the center of the arc. Set the dividers at the desired radius. (Fig. 160.) Place one point of the dividers at the intersection, and before drawing the arc, swing the dividers to both edges testing to see if the center is located accurately. In drawing the arc, do not press the center point deeply into the wood.

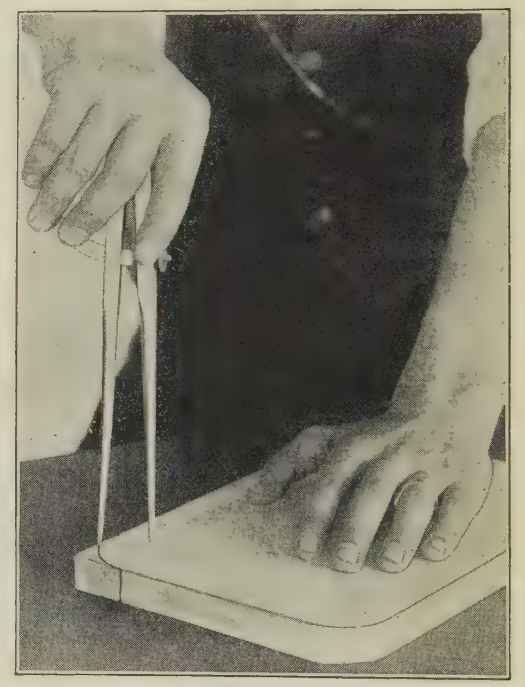


Fig. 160. Draw the arc of a rounded corner with a compass or dividers

PROCEDURE E: To Lay Out an Ellipse

Lay off the major and minor axes, AB and CD, at right angles to each other, intersecting at their center O. (Fig. 161.) With one half of the major

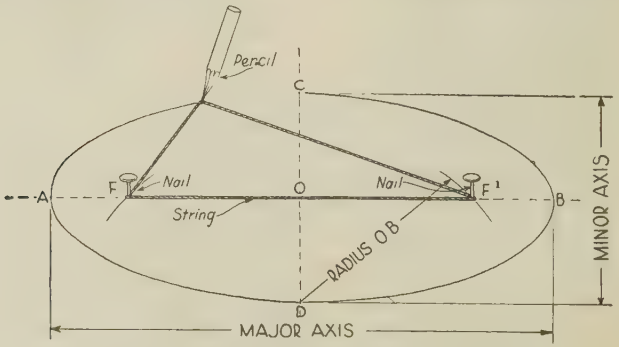


Fig. 161. Method of laying out an ellipse

axis, OB, as a radius, and the end of the minor axis, D, as the center, describe an arc locating the foci, F and F′, on the major axis. Drive small nails at the two foci, F and F′. Make a loop of string of sufficient length to reach from either nail to the opposite end of the major axis.

Place the loop around the nails, and insert a pencil. Pull the string tightly, and draw the ellipse. Figure 162 shows the drawing for an elliptical bread board.

PROCEDURE F: To Lay Out Irregular Curves from Drawings

The use of patterns is recommended for irregular curves. If the pattern is not furnished, make your own. If the drawing is not cross sectioned, make a full-size drawing of the part containing the curves, and draw in the curves free-hand. If the design is symmetrical, lay out the pattern for one side only. Reverse the pattern to lay out the other side. (Fig. 153.)

If the working drawing is cross sectioned, make a full-size drawing of the part. To aid in laying out the curves, draw in full-size cross sections equal in number to those in

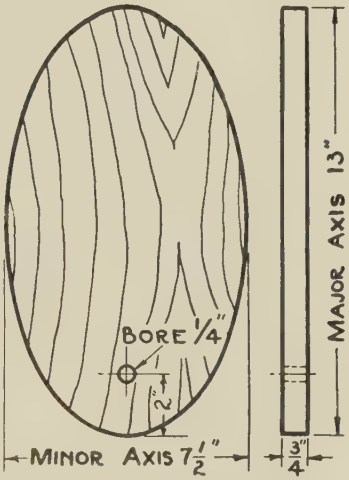


Fig. 162. An elliptical bread or cutting board

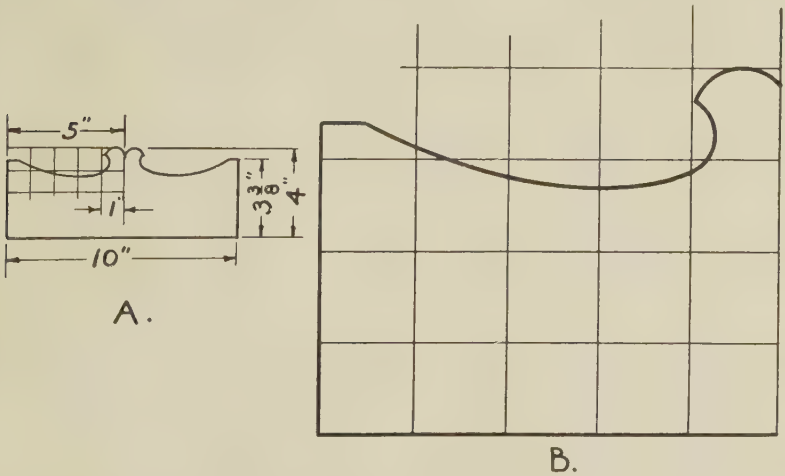


Fig. 163. A, cross-sectional working drawing; B, a full-size template for making the curve

the working drawing. (Fig. 163.) Draw the curves in each square similar to the curve in the corresponding square in the working drawing.

Before the pattern is cut out, have it inspected by the instructor.

QUESTIONS:

1. What is a template?
2. What is the advantage of using a template?
3. What precautions should be taken in laying out with a template?
4. What is a regular hexagon?
5. Where may a hexagon be used?
6. What is the relation between the radius of the circumscribed circle and the side of a hexagon?
7. What is an octagon?
8. What is drawn first in laying out a regular octagon?
9. What distance is used as the basis for laying out an octagon?
10. How is the center of an arc for a rounded corner located by measurement?
11. What tools are used to lay out the arc of a rounded corner?
12. What dimensions are necessary to lay out an ellipse?
13. What is the purpose of the nails at the foci of an ellipse?
14. Where may an ellipse be used?
15. When a drawing is symmetrical, why make only half a pattern?
16. What is the use of cross sectioning in transferring curves?

SUGGESTED PROBLEMS:

1. Lay out different hexagons, octagons, and ellipses.
2. Transfer irregular curves by the cross-section method.
3. Lay out rounded corners.
4. Make patterns and templates for different designs.

UNIT 20

TO SAW CURVES

Sawing curves requires a saw with a narrow blade. A narrow blade is necessary so that the direction of the saw can be changed to conform to the curve. Very sharp curves require the narrowest blade. In sawing outside curves, the saw can be started on the edge of the stock. A hole

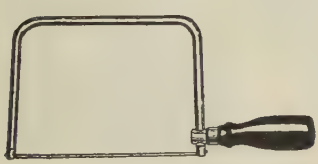


Fig. 164. Coping saw

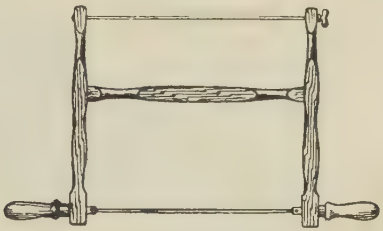


Fig. 165. Turning saw

must be bored to start the saw for inside curves. Coping and turning saws are generally used for sawing outside curves. The coping saw (Fig. 164) is used on thin or small pieces, and the turning saw (Fig. 165) on thick, large pieces. The compass saw (Fig. 166) is commonly used to saw inside curves. However, the coping or turning saw also may be used on inside curves.

Tools: Coping saw; turning saw; compass saw; brace and bits; vise; saw jack or bracket; screw clamp.

Material: Stock on which curves are laid out.

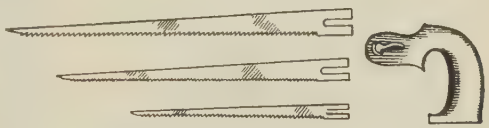


Fig. 166. Compass-saw handle with blades of different sizes

PROCEDURE A: To Saw Outside Curves with a Coping Saw

1. Lay out the curve

Square up the stock, if necessary, and lay out the curve. See Units 9 and 19. Curves are often transferred immediately to parts of the rough-stock list that have been surfaced or mill planed. In this case, it is not necessary to square up the stock.

2. Clamp or hold the stock

Clamp the stock in the vise, or use the coping-saw jack or bracket. (Figs. 167 and 168.) The jack or bracket is a board with a V cut at the end. This V supports the stock, allows free use of the saw, and protects the bench from saw cuts.

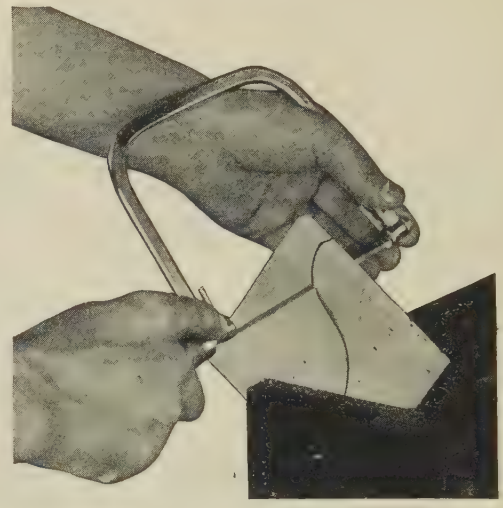


Fig. 167. Sawing a curve with a coping saw when the stock is clamped in a vise

3. Saw the curve

When the stock is held in the vise, both hands can be used on the saw. (Fig. 167.) In this case, the blade usually is inserted in the frame so that the teeth point away from the handle. The use of two hands guides the saw more accurately and lessens the chances of breaking the blade. When a saw jack or bracket is used, the stock must be held in position with one hand, while the other is used to operate the saw. (Fig. 168.) In this illustration, the teeth of the blade point toward the handle and cut on the downward stroke. Various positions are used in sawing with the jack or bracket, and the teeth must always point in the direction of the cutting stroke.

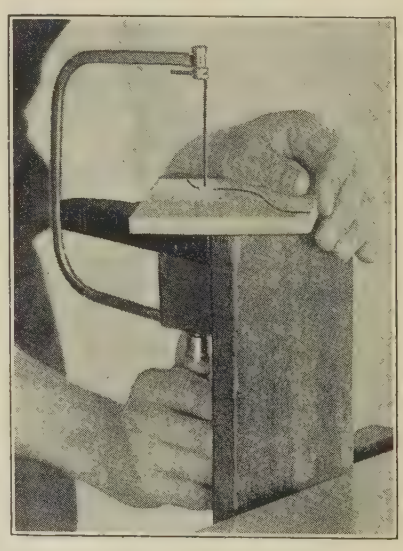


Fig. 168. A method of using a coping-saw bracket

Hold the saw square, with the work in both directions, and saw in the waste stock outside the line. Do not force the saw. Use straight, uniform strokes to prevent breaking the blade. Change the angle of the blade in the frame when the edge or end of the piece interferes in sawing.

On wide stock, saw to the center of the piece from one edge. Remove the saw, and complete the cut from the other side.

PROCEDURE B: To Saw Outside Curves with a Turning Saw

The turning saw is used on thicker stock. The manner of using it is similar to that of the coping saw. Clamp the stock securely, and use both hands to operate the saw. Figure 169 shows one method.

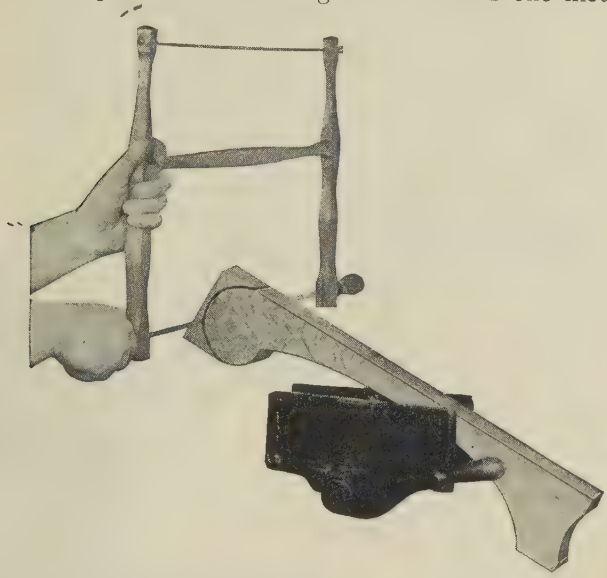


Fig. 169. Use the turning saw to saw curves in heavy stock

PROCEDURE C: To Saw Inside Curves with a Compass Saw

1. Lay out the curve

See Procedure A, step 1.

2. Bore a hole for an inside curve

For inside curves, it is necessary to bore a hole for starting the saw. If there is plenty of room in the waste stock, use an auger bit, and bore just to the line. Oftentimes the proper size of auger bit will make a part of the

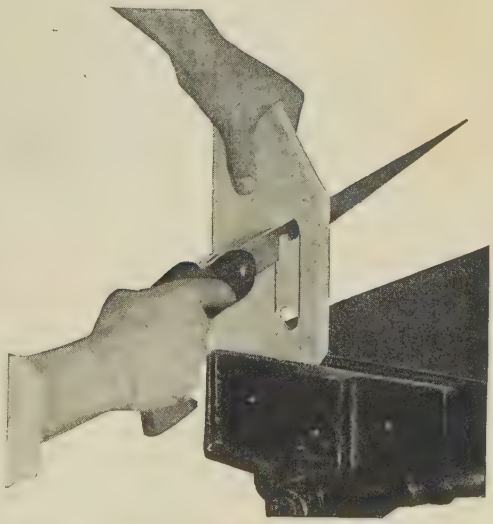


Fig. 170. Often an auger-bit hole can be made to form part of a design

curve. (Fig. 170.) Where space is limited, use a small bit, and bore a succession of holes which will allow the saw to enter. The diameter of the bit should be slightly more than the thickness of the blade of the saw. Three or four holes, bored close together and in a straight line, usually are enough when a pointed saw blade is used. These holes should be bored in the waste stock, so that the design will not be affected. A small "keyhole" saw may be used to advantage in starting the cut, which can then be completed with a larger compass saw.

3. Clamp or support the stock

Clamp small parts in the vise. (Fig. 171.) Place large and heavy pieces on sawhorses, and hold them in place with the hand or knee.

4. Saw the curve

Insert the saw in the hole, and start with short, uniform strokes. Saw in the waste stock to the line. Do not force the saw; the narrow blade may bend or buckle. Small compass saws are called "keyhole" saws, (Fig. 172), and are used to saw small, sharp curves. If it is desired to use a coping or turning saw on inside curves, remove the blade, insert it in the hole, and again attach the blade to the frame.

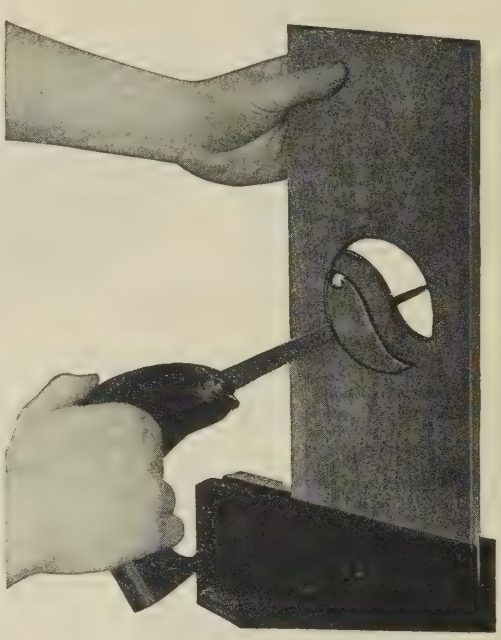


Fig. 171. Sawing a design in a panel

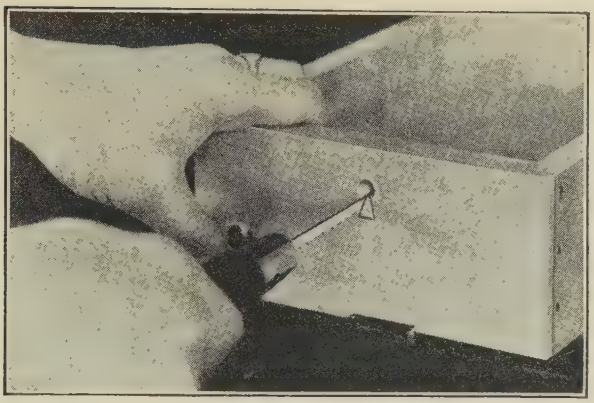


Fig. 172. A small compass saw is useful in making keyholes

QUESTIONS:

1. What kind of blade is necessary in sawing curves?
2. How does a narrow blade allow the sawing of curves?
3. How must the saw be started in sawing inside curves?
4. Where is the saw started in sawing outside curves?
5. What saws are generally used for sawing (*a*) outside curves; (*b*) inside curves?
6. What is a coping-saw jack or bracket?
7. What is the advantage in the use of the jack or bracket?
8. What is the advantage of using two hands on the coping saw?
9. How should the teeth point when cope sawing?
10. Why must the coping saw be handled carefully?
11. When is a turning saw used?
12. When can a large hole be bored in starting a compass saw?
13. What might be the advantage in selecting a special-size auger bit for starting a compass saw?
14. When would a succession of holes be bored for starting a compass saw?
15. What is a keyhole saw?

UNIT 21

TO SHAPE CURVED SURFACES

The common planes and chisels are generally used for producing straight surfaces. However, a special circular plane, Figure 173, will plane curves, and the common chisel is used for paring curved surfaces. Paring is the process of removing a thin shaving from a piece of stock. This is done with sharp-edged tools like the chisel. The spokeshave, drawknife, and gouge are tools specially designed for producing curves. The chisel is often used to pare a rounded corner or to produce the curves on the ends of a stop chamfer. The spokeshave is used to form handles and rods, and to shape curved edges, both concave and convex. The gouge is a chisel with a curved blade used to produce round grooves or hollows. The drawknife is used principally in roughing down to straight as well as curved lines.

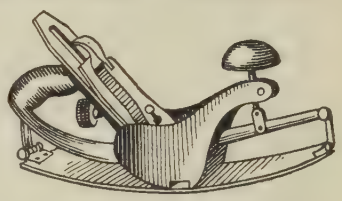


Fig. 173. An adjustable circular plane may be used to plane convex or concave curves

The woodworker's rasp and the cabinet file are sometimes used to shape or smooth curved surfaces. They are useful for forming round holes or in shaping any curve that has been roughed down approximately to the line. It is advisable to use the cabinet file or rasp only when the paring tools cannot be used to advantage.

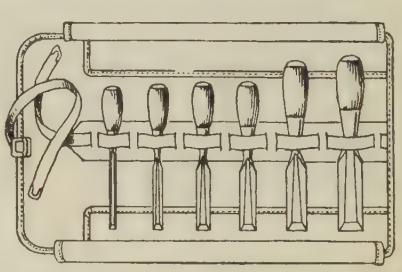


Fig. 174. A set of the common sizes of beveled-edge chisels of the socket type

Tools: Common chisel (wider than stock to be pared); drawknife; spokeshave; gouge (outside or inside bevel of size to suit).

Material: Curves to be smoothed or pared.

PROCEDURE A: To Pare Curves with the Common Chisel

The chisel is a bevel-edged tool. The size of a chisel is the width of the cutting edge in inches. They can be obtained from $\frac{1}{8}$ to 2 in. wide and in different lengths. Figure 174 shows a set of chisels of

the socket type, ¼ to 1½ in. in width. The edges (sides) of the blades shown are beveled, but some blades have square edges. These chisels can be used by hand as well as with the mallet. The chisel is used in paring a curve with a short radius. Figure 175 shows the chisel in use in paring a rounded corner. Note that the direction of the stroke is toward the end grain. Hold the chisel at a slight angle and allow it to slide laterally to produce a shearing cut. One hand is placed on the blade of the chisel near the cutting edge to regulate the cut. Always chisel in the uphill direction of the grain and toward the waste stock. Figure 176 shows the chisel used in paring a stop chamfer. The chisel is a very handy tool in the woodworking shop, as it can be used for a variety of operations. A common saying is "when in doubt what tool to use, select a chisel."

Fig. 175. Paring a corner with a chisel

PROCEDURE B: To Pare with a Drawknife

The drawknife (Fig. 177) is a bevel-edged tool used to pare both straight and curved surfaces. It is a long knife with two handles by means of which it is drawn to produce the cut. The size of the draw-

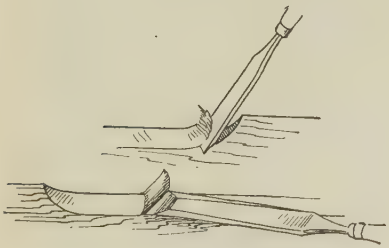


Fig. 176. Stop chamfering with a chisel

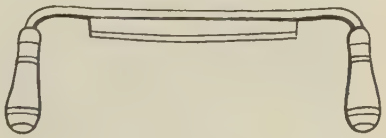


Fig. 177. Drawknife

knife is the length of the blade in inches. An 8- or 10-in. drawknife is a common size. It can be used to pare thin shavings as well as to slice off large pieces in roughing down to the line. Clamp the stock securely in the vise. Note the direction of the grain, and pare in the uphill direction. Hold the blade at an angle and allow it to slide laterally to

produce a shearing cut. Figure 178 shows the drawknife removing waste stock in roughing down to a curved line. The curve on the end of a stop chamfer is being produced with a drawknife in Figure 179. Note that the bevel is down to conform to the curve. In finish work

Fig. 178. Removing the waste stock with a drawknife

of this sort, take light cuts to prevent digging in or splitting the piece. A drawknife is ground similar to a plane iron. The edge is easily whetted (Fig. 180) by holding the blade still and rubbing the stone over the bevel in a circular motion.

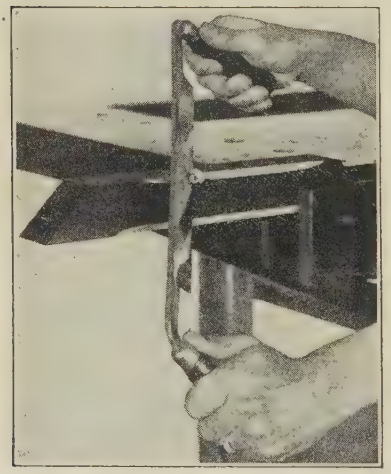


Fig. 179. Stop chamfering with a drawknife

Fig. 180. Whetting a drawknife

PROCEDURE C: To Shape Curves with a Spokeshave

The spokeshave is specially adapted for shaping curves. It is, in reality, a very short plane with handles on the sides. The depth of the cut is usually regulated by a screw. The shortness of the bed allows it to conform to the shape of the curve. It usually is pushed when in use, but may be pulled if desired. In using the spokeshave, follow the general directions for planing. The blade is ground similar to a plane iron, and is whetted as shown in Figure 181.

Fig. 182. Iron spokeshave

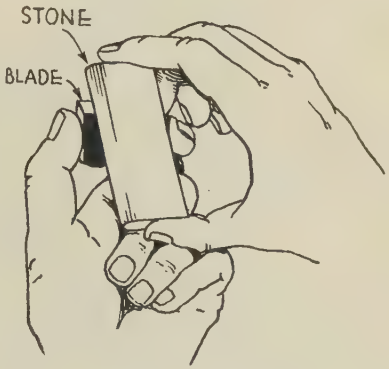


Fig. 181. Whetting a spokeshave blade with a slip stone

Figure 182 shows a spokeshave containing both straight and curved blades. The handle of a stilt is being rounded with a spokeshave in Figure 183 and a concave curve is being produced in Figure 184.

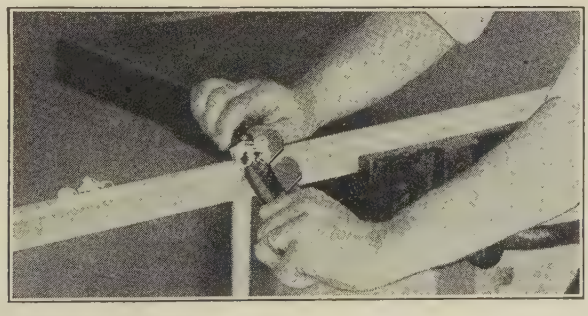


Fig. 183. Rounding the handle of a stilt with a spokeshave

PROCEDURE D: To Pare Curves with a Gouge

The gouge is a chisel whose section is curved; that is, it has a curved blade. The size of a gouge is the distance between the corners of the cutting edge. They are furnished from $\frac{1}{8}$ to 2 in. wide and with flat, medium, or regular sweep. The gouge is a bevel-edged tool with the bevel on either side. If the bevel is on the inside of the curve, it is called an "inside-bevel" gouge. An "outside-bevel" gouge has the bevel on the outside of the curve. Figure 185 shows an outside and an inside-

bevel gouge together with the different sweeps. When using an inside-bevel gouge (Fig. 186) the blade must be held parallel with the groove being pared. If held too high or out of line, it will dig in.

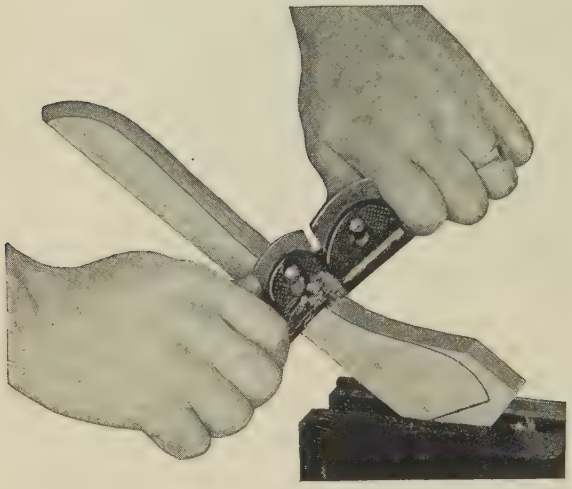


Fig. 184. Forming a curve with a spokeshave

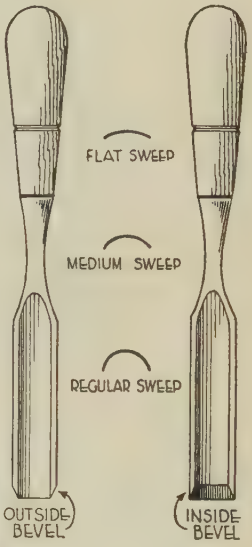


Fig. 185. Outside and inside bevel gouges can be obtained in different sweeps

The handle of the outside-bevel gouge can be raised when cutting. (Fig. 187.) This prevents interference of the handle with the work. For this reason, it is used more than the inside bevel. This gouge is useful in cutting concave hollows and the ends of grooves, as well as for general gouging.

When g o u g i n g, take thin, long shavings, if possible. Rotate the cutting edge slightly as the g o u g e is pushed forward. This will give a shearing cut.

The inside-bevel gouge must be ground on a special w h e e l and whetted with a slip stone.

The outside-bevel g o u g e is ground to the same angle as a plane bit, by rotating on the g r i n d i n g wheel. Whet it by holding the bevel flat to the

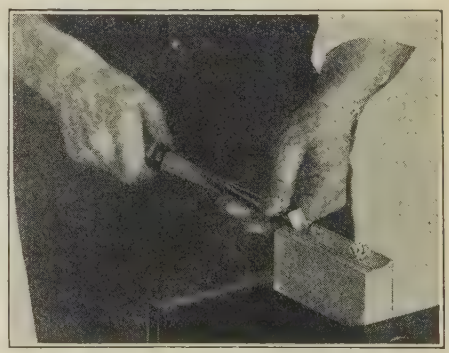


Fig. 186. Inside-bevel gouge in use

Fig. 187. Gouging with an outside-bevel gouge

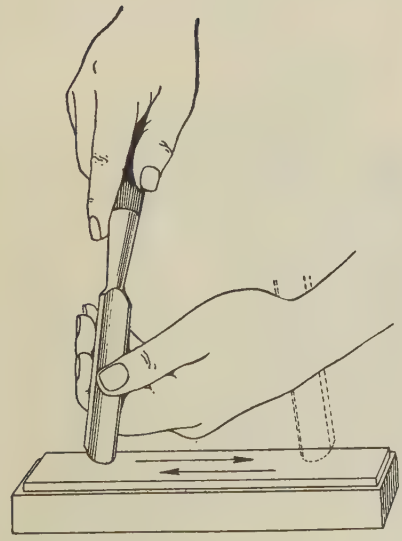


Fig. 188. Whetting an outside-bevel gouge

Fig. 189. Removing the wire edge in whetting an outside-bevel gouge. Arrows show direction of strokes

stone. (Fig. 188.) Slide the gouge back and forth, rotating the blade so that the entire bevel comes in contact with the stone during the stroke. Remove the wire edge from the inside of the curve with the proper-size slip. (Fig. 189.) Keep the slip flat on the blade to keep from forming a bevel on the inside.

PROCEDURE E: To Shape a Curve with a Cabinet File or Rasp

The woodworker's rasp, Figure 190, is used for roughing a curve to the line, while the cabinet file, Figure 191, is used to produce a

Fig. 190. Half-round woodworker's rasp

Fig. 191. A cabinet file

smoother surface. The good workman usually uses an edge tool, and only resorts to filing where it is necessary.

In shaping a curve with a cabinet file, Figure 192, use a diagonal stroke. As the file is pushed forward, move it to the right or to the

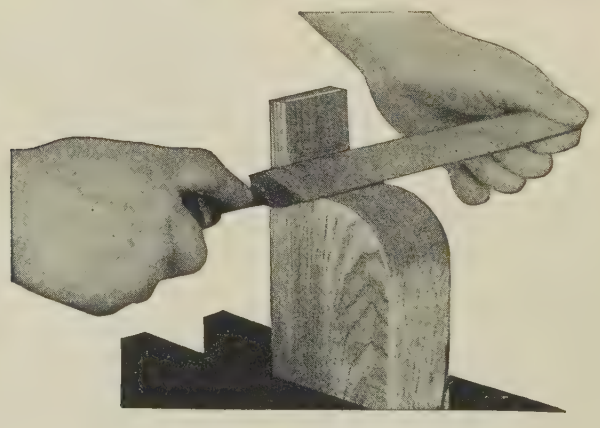


Fig. 192. Shaping a curve with a cabinet file

left. This will produce a more uniform curve, and avoid the making of hollows and grooves. It will also prevent the chipping of the edges in filing end grain.

The wood tends to clog the teeth of the file, and necessitates frequent cleaning with a file card. (Fig. 193.)

Fig. 193. Cleaning a file with a file card

QUESTIONS:

1. What tools are used for producing both straight and curved surfaces?
2. What tools are designed especially for producing curved surfaces?
3. What is paring?
4. Name a common tool used in paring.
5. When are the rasp and cabinet file used to shape a curve?
6. In what direction should you chisel when paring a rounded corner?
7. Why pare toward the waste stock?
8. How does a stop chamfer differ from a through chamfer?
9. Why is the chisel such a handy tool?
10. What is a common saying concerning a chisel?
11. A drawknife is used in what direction with the grain?
12. For what is a drawknife generally used?
13. What precautions should be noted in using a drawknife?
14. How is a drawknife sharpened?
15. The spokeshave is in reality what kind of tool?
16. What may be formed with a spokeshave?
17. What kind of tool is the gouge?
18. How are the sizes of gouges indicated?

19. What is meant by the sweep of a gouge?
20. Name the different gouges.
21. Why is the outside-bevel gouge generally used?
22. What is the use of the gouge?
23. How is an outside-bevel gouge sharpened?

UNIT 22

TO BORE WITH BRACE AND AUGER BITS

Boring holes is a frequent operation, and is comparatively easy if certain precautions are taken. The hole must be accurately located, must be bored in the proper direction, and care must be taken when the hole extends through the stock, to prevent splitting the pieces when the bit comes through.

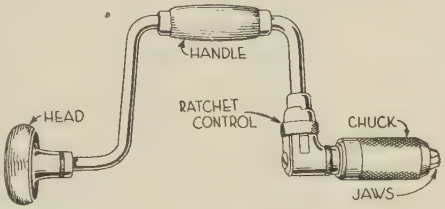


Fig. 194. The parts of a brace

Holes ¼ in. or more in diameter usually are bored in wood with a brace and auger bits. The brace (Fig. 194) is equipped with jaws into

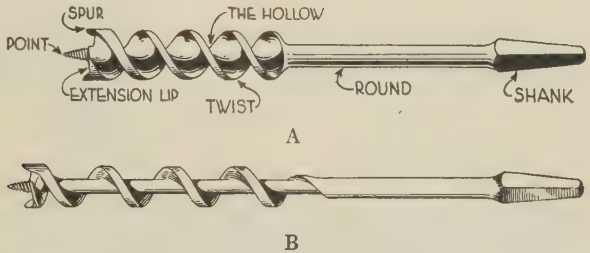


Fig. 195. A, auger bit with names of parts; B, auger bit with solid center

which the shank of the auger bit can be securely fastened. There are a number of types of bits and each type is designed for a particular purpose. The common types are the "common auger bits" (Fig. 195), the

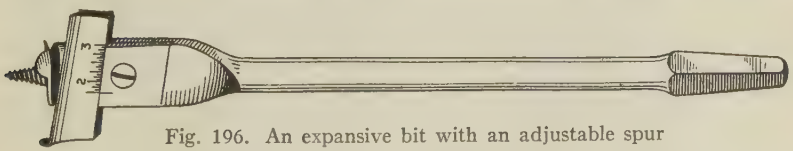


Fig. 196. An expansive bit with an adjustable spur

"expansive auger bit" (Fig. 196), and the "Forstner bit." (Fig. 197.) The sizes of auger bits vary by sixteenths of an inch. Bits should be kept sharp by filing with an auger-bit file whenever necessary.

Tools: Brace and auger bits; auger-bit file; depth gauge; awl; rule.

Material: Stock in which holes are to be bored.

Fig. 197. Forstner bit

PROCEDURE:

1. Note the specifications for the hole

Note the location and size of the hole on the working drawing. It also is well to note the direction and depth, and whether or not it extends through the piece.

2. Select the bit

Holes ¼ in. and above are usually bored with auger bits. The common auger bits (Fig. 195) have square shanks, and range in size from

Fig. 198. An auger-bit file

3/16 in. by sixteenths to 1 in.* The size is stamped on the square shank, and the number is the diameter in sixteenths. A No. 7 is 7/16 in. in diameter. For holes above 1 in., select an expansive auger bit. (Fig. 196.) These bits have adjustable cutters, and different sizes can be had that will bore holes from ½ to 4 in. The Forstner bit (Fig. 197) does not have a point, and is useful in boring where the point would come through or split thin stock. The size is indicated as in auger bits. They can be obtained in sizes from ¼ to 2 in.

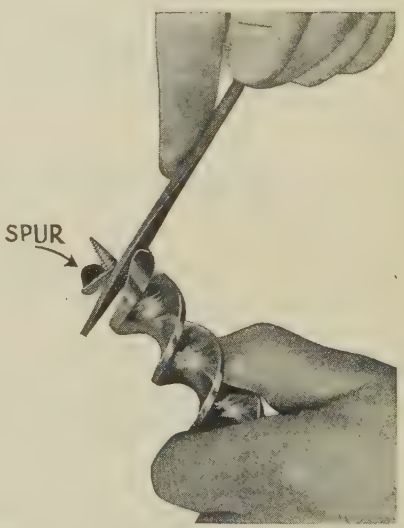


Fig. 199. Hold the bit firmly against the edge of a bench or other support when filing the auger bit spurs on the inside

A good plan for boring holes would be to select twist drills (or drill points) for holes less than ¼ in., auger bits for holes ¼ to 1 in., and expansive bits for holes larger than 1 in.

*Note: Auger bits also can be obtained from 3/16 to 16/16 in. inclusive by 32nds, and from 16/16 to 32/16 in. inclusive by sixteenths. These sizes are seldom carried in the average shop.

If the bit selected is not sharp, take it to the instructor for sharpening or for special instruction on filing. Bits are easily sharpened by an expert with an auger-bit file (Fig. 198), but they are just as easily

Fig. 200. File the auger-bit lips on the upper side

spoiled by an amateur. To sharpen, file the spurs (Fig. 199) on the inside in order to retain the correct diameter of the bit. File the lips on the upper side (Fig. 200), that is, on the side next to the shank. Remove any burrs with a small slip stone.

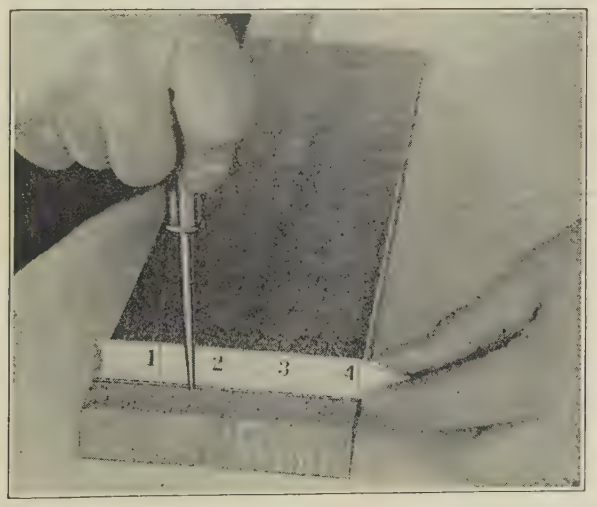


Fig. 201. Locating the center of a hole with an awl

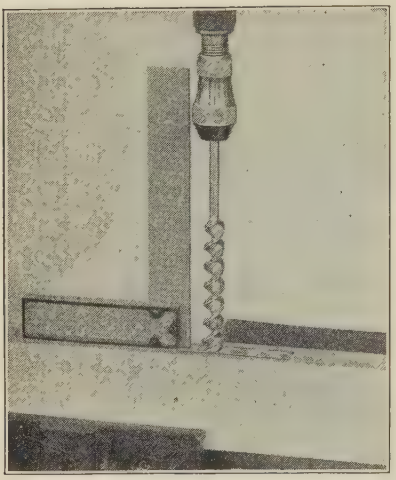


Fig. 202. A try-square will aid in boring a perpendicular hole

3. Fasten the bit in the brace

Select a brace for all bits with a square shank. Note the parts of the brace in Figure 194. A ratchet brace can be rotated back and forth in only part of a circle. This is necessary where the brace cannot make an entire revolution. A knurled collar controls the ratcheting device. To insert a bit, open the jaws wide to receive the square shank. The square shank should be entirely inclosed. The jaws will clamp the round part of the shank firmly when the bit is properly held in place.

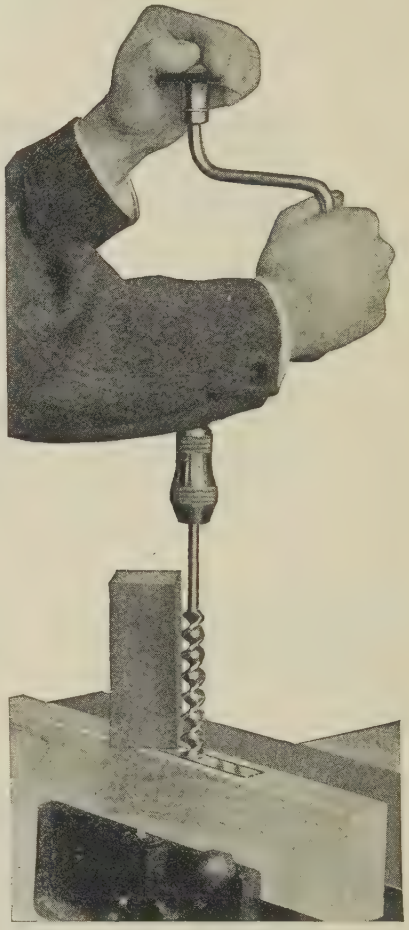


Fig. 203. A block may be used as a guide and depth gauge when boring

4. Locate the hole

Locate the exact position of the hole by marking its center with two intersecting lines, then center-punch with a scratch awl. (Fig. 201.) This will help to start all holes accurately.

5. Bore the hole

Bore the hole in the proper direction. In most cases, holes are bored perpendicular to the surface. Beginners may use a try-square as a guide. (Fig. 202.) The angle must be checked in two directions at right angles to each other. A block used as a guide (Fig. 203) will serve as a depth

gauge. Sight as you bore, to check these angles. Another person can aid to advantage in checking the direction of the bit. Make sure that the bit is started in the proper direction. Do not attempt to change the direction after the bit has entered well into the wood. This will bend or break the bit. Use care to avoid nails or other metal in boring.

The function of the threads on the point of the bit is to draw the bit into the wood. In soft woods, but little pressure is needed when boring. In hard woods, where cutting is difficult, it often is necessary to apply considerable pressure as you bore. It is important that you reduce the pressure gradually as the point of the bit appears, when boring a through hole.

Bore a through hole by boring from one side of the piece until the point appears on the opposite side. (Fig. 204, A.) Reverse and finish boring from the opposite side. If it is impossible to reverse the boring, a piece of scrap stock clamped to the back will prevent splitting (Fig. 204, B) as the bit comes through.

Fig. 204. A, stop boring when the point appears; B, boring all the way through may split the piece

Bore a hole to depth by clamping a depth gauge to the bit. Check the depth on the bit with a rule, and tighten the depth gauge. If an adjustable depth gauge (Fig. 205) is not available, a block with a hole in it (Fig. 206) will serve the purpose. Cut the block to proper length and check the measurement.

Figure 207 shows the use of an expansive bit.

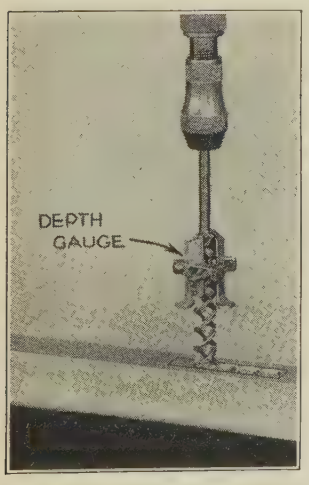


Fig. 205. An adjustable depth gauge

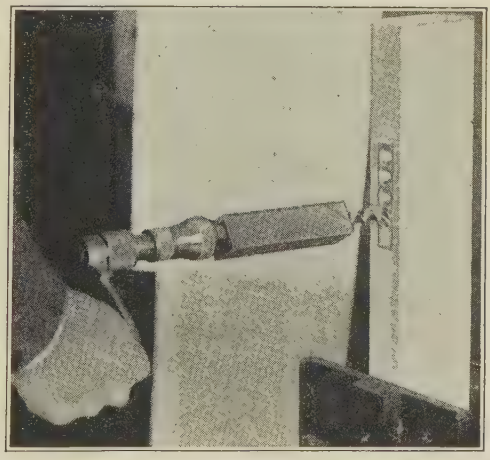


Fig. 206. A block with a hole in it will serve as a depth gauge

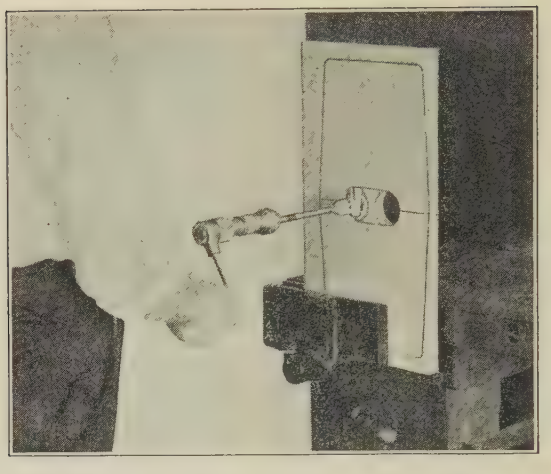


Fig. 207. An expansive bit used to form part of a design

QUESTIONS:

1. What is boring?
2. What precautions must be taken in boring?
3. What is commonly used to bore holes ¼ in. or more in diameter?
4. Name the different types of auger bits.
5. How do auger bits vary in size?
6. How is the size indicated?
7. What does the number "9," stamped on the shank of the bit, indicate?
8. For what are expansive bits used?
9. When should a Forstner bit be used?
10. What is used to sharpen an auger bit?
11. Name the parts of an auger bit.
12. What is the purpose of (*a*) the jaws on a brace; (*b*) the ratchet?
13. What is the advantage in locating a hole with an awl?
14. What may be used as a guide to aid in boring a hole perpendicularly?
15. Why should the angle be checked in two directions when boring a perpendicular hole?
16. What may happen if the direction of the bit is changed after it has entered well into the wood?
17. What should be done when boring a through hole?
18. What is the advantage in using a depth gauge?
19. How can a depth gauge be made?

UNIT 23

TO BORE WITH TWIST DRILLS OR DRILL POINTS

Often small holes must be bored in wood for screws (Fig. 208), nails, or small bolts. Such holes less than ¼ in. in diameter are usually bored with twist drills or drill points. Bit-stock drills (Fig. 209) are twist drills with square shanks. They are used in the brace to bore the larger of the small holes. The hand drill and the automatic drill (Fig. 212) are used to bore the smaller holes. Straight-shank drills (Fig. 210) are used in the hand drill. Drill points (Fig. 214) are made with special shanks to fit the chuck of the automatic drill.

The common twist drills vary in size by 64ths of an inch. The number stamped on the shank indicates the size.

Tools: Brace; hand drill; automatic drill; twist drills or drill points; awl.

Material: Stock to be bored.

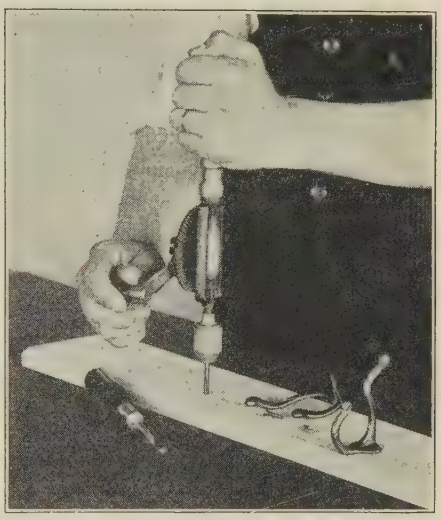


Fig. 208. Boring small holes for screws with a hand drill

Fig. 209. A bit-stock drill used for boring in wood or metal

Fig. 210. A straight-shank twist drill

PROCEDURE:

1. Determine the size and location of the holes

Most of the holes bored with twist drills or drill points are used for driving screws or nails. The position and size of such holes must then

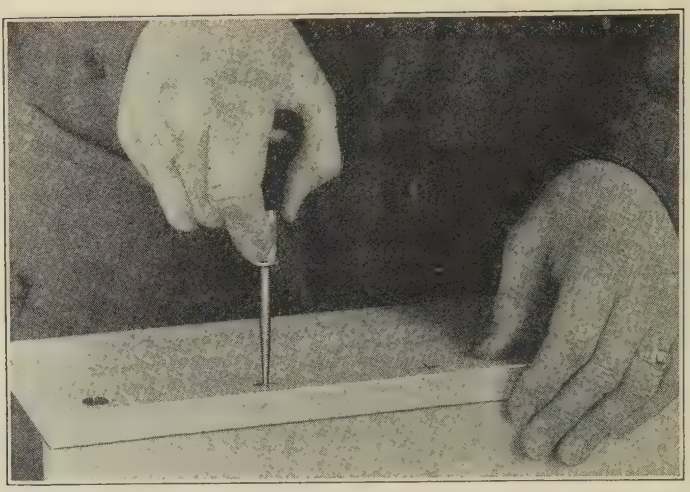


Fig. 211. An awl or center punch will aid in starting a drill accurately

depend on the position and size of the fasteners. (See Figure 256 for the recommended drill sizes for the common screws.) The position of the hole may determine the tool to be used for boring.

Locate and mark the hole with an awl or center punch. (Fig. 211.) This will aid materially in starting a twist drill in the proper place.

2. Select the tool for holding the bit

A brace (Fig. 194) must be used for all bit-stock drills, since such bits have a square shank. Use a brace for boring when there is plenty of room, when the hole is large, and when the wood is hard. A brace gives more power when drilling in metal.

A hand drill (Fig. 208) is used for all straight-shank drills. It is commonly used to drill small holes and in places

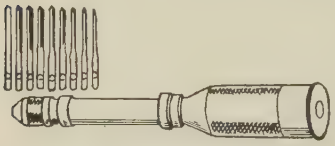


Fig. 212. Automatic drill with special drill points

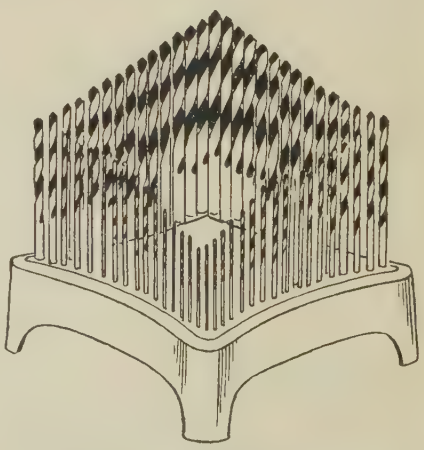


Fig. 213. A metal stand is convenient for straight-shank drills

where a brace would be cumbersome. There is less danger of breaking bits with a hand drill than with a brace.

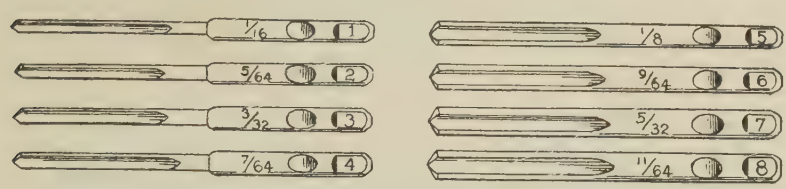


Fig. 214. Automatic drill points can be obtained in sizes from 1/16 in. to 11/64 in. by 64ths

The automatic drill (Fig. 212) is a small, handy tool used mainly in setting small screws. It is convenient in putting on hardware and boring for nails where there is danger of splitting. The tool is rapid in its action, and occupies a small amount of space in the carpenter's tray.

3. Select the bit

Select a bit of the proper size and proper shank to fit the boring tool. Straight and square-shank bits for metal or wood vary in size by 64ths of an inch. The small sizes range from 1/16 to ¼ in. Larger sizes are obtainable. The exact sizes are usually stamped on the shank of the bit. Straight-shank bits also can be obtained in sizes, by number, from 60 to 1. The number refers to the wire gauge of the bit. A metal stand, as shown in Figure 213, is handy to tell the sizes of straight-shank drills, as well as to hold them.

Automatic drill points are made purposely for the automatic chuck. They can be used, however, in the hand drill. They vary from 1/16 to 11/64 in. by 64ths. The exact size is stamped on the shank. (Fig. 214.)

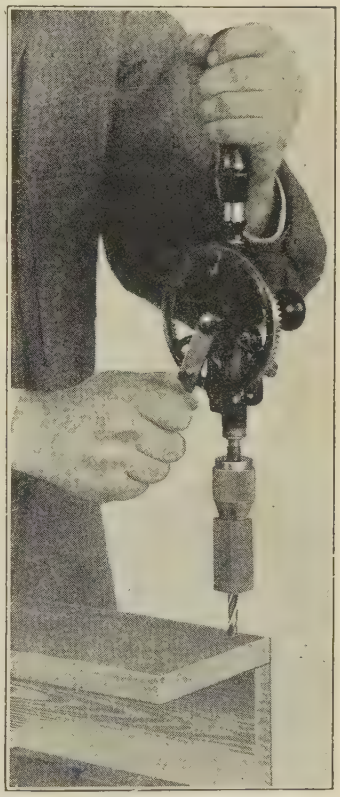


Fig. 215. A scrap piece of stock will serve as a depth gauge

Twist drills are best sharpened with a special grinding attachment for the grinding wheel. This attachment automatically gives the proper

angle and lip clearance. The angle between the cutting edge and the axis should be 59 degrees. Experience has shown that twist drills ground at this angle work more satisfactorily than the old-type, sharp-pointed, wood twist bit. The edges should be straight, of equal length, and have a lip clearance of from 12 to 15 degrees.

4. Bore the hole

Note the depth of the desired hole. If a number of holes of the same depth are to be bored, time will be saved by boring a hole in a scrap piece of stock and cutting it to length to serve as a depth gauge. (Fig. 215.)

Hold a brace and bit-stock drill steady while boring. Wobbling or change of direction may break the bit. Turning the brace with slow, uniform motion will give the best results. When the hole has been drilled to the proper depth, keep turning as the bit is withdrawn. Clamping a piece of stock on the back side will reduce the tendency of splitting as the bit comes through.

Hold a hand drill steady, and apply light pressure while turning the crank. It is best not to force the cutting of the bit.

The automatic drill requires extreme care when boring. It is essential that the tool and bit be kept in alignment during the stroke. Careless handling will result in broken bits.

QUESTIONS:

1. For what purpose are small holes bored in wood?
2. What tools are commonly used to bore holes less than ¼ in. in diameter?
3. What are bit-stock drills?
4. What drills are used in (*a*) the hand drill; (*b*) the automatic drill?
5. How do the common twist drills vary in size?
6. How is the size indicated?
7. In boring a hole for a nail or screw, what determines the size of the hole?
8. What can you do to aid in starting a twist drill in the proper place?
9. When would you use a brace and a bit-stock drill?
10. What is the advantage in the use of (*a*) the hand drill; (*b*) the automatic drill?
11. How are twist drills best sharpened?
12. What kind of depth gauge could be used on a small twist drill?
13. Why is it necessary to hold the brace steady when boring with a small bit-stock drill?
14. How can the splitting of the piece when boring a through hole with a twist drill be prevented?
15. How can breaking or bending the bit when boring with an automatic drill be prevented?

UNIT 24

TO CLAMP STOCK

Clamping is a temporary method of fastening frequently used in woodwork. Stock is clamped together for gluing, nailing, or any other method of fastening. The clamp holds the joint in place until the glue sets, or until other methods of fastening have been completed. Clamps

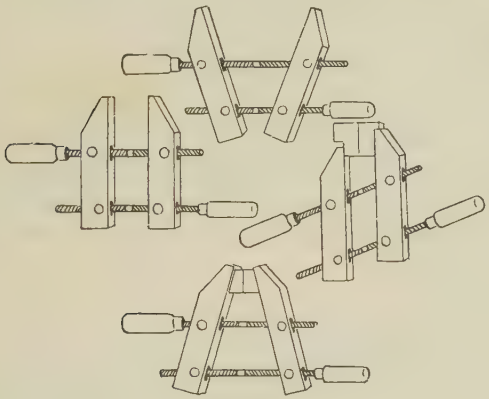


Fig. 216. The adjustable hand screw adjusts to different angles

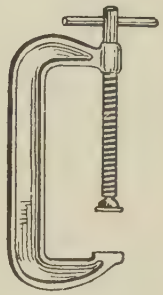


Fig. 217. Screw or C clamp

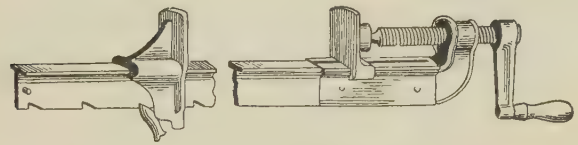


Fig. 218. Steel bar clamp

are also used to hold parts together temporarily, to fasten apparatus or projects tightly to the bench while work is done on them, and to make a trial assembly of a joint or frame before the final assembly and fastening is made. The woodworker's vise is a clamp; and what is more useful or more often used than the vise?

The common movable clamps are the wood hand screws (Fig. 216), the screw or C clamp (Fig. 217), and the bar clamp. (Fig. 218.) The

hand screws and screw clamps are used for clamping small parts and in gluing face to face, while the bar clamps are used on large work as in gluing stock edge to edge and in the assembly of frames for all kinds of cabinet and carpentry construction.

The general procedure in clamping is as follows:

1. Prepare blocks for the clamps.
2. Adjust the clamps for the length of opening.
3. Determine the number and position of the clamps.
4. Clamp.

Tools: Bar clamps; hand screws; screw clamps.

Material: Stock to be glued, fastened, or assembled; glue, nails, screws, or other fasteners; blocks.

PROCEDURE A: To Clamp with Bar Clamps

Bar clamps are the longest clamps, and are used where any wide assembly is to be made. The common type is the steel bar with a screw at one end and an adjustable jaw at the other. The screw allows great pressure to be produced easily. The adjustable or movable jaw slides along the bar and catches at the numerous notches arranged for the dog. The bar clamp, therefore, is adjustable to many lengths. It is furnished in lengths from 1 to 8 ft.

1. Prepare blocks for the clamp

On all finished work, hardwood blocks should be used under the clamps to prevent marring the stock. Scrap pieces of stock should be used to make the blocks. No special shape is necessary, but a smooth surface should be placed next to the finished piece.

2. Adjust the clamp

Turn the screw all the way back. Place clamps temporarily on the job to be clamped and move the adjustable jaw to the desired length. Allow for the blocks if they are not held in place at the time of adjustment. The clamp can also be set by measurement.

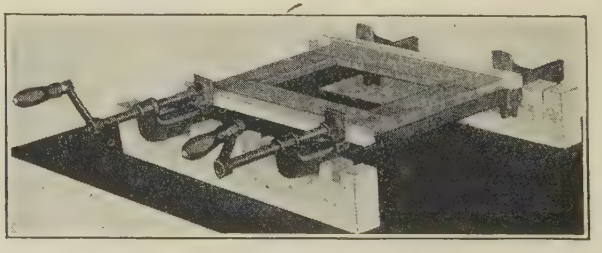


Fig. 219. Clamping a frame with bar clamps. Note the blocks used to protect the edges of the frame

3. Determine the number and position of the clamps

It is best to decide on the number of clamps to be used. This will give a systematic arrangement. The ordinary frame usually needs only

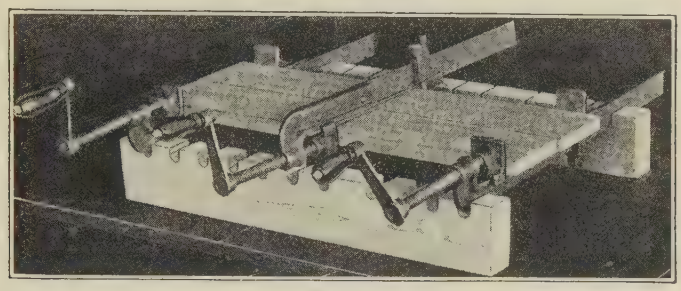


Fig. 220. Alternate the clamps to prevent buckling

two clamps. (Fig. 219.) In clamping stock for edge-to-edge gluing, the clamps should be alternated on opposite sides of the stock to keep the boards from buckling. (Fig. 220.) The clamp rack shown in Figures 219 and 220 will hold the clamps in place until they can be tightened.

4. Clamp

Place the clamp in position, arrange blocks under the jaws, and turn the handle with only a moderate amount of pressure. An enormous pressure can be secured with the screw of a clamp, so it is best to turn the handle with caution. Note carefully when the joint comes together properly, and stop turning before too much force is exerted.

In the final assembly of a project, it is advisable to divide the work into units for clamping. This will allow more time for gluing and getting the joints square or true. This may be necessary also because of the lack of clamps. The common frame, consisting of four legs, four

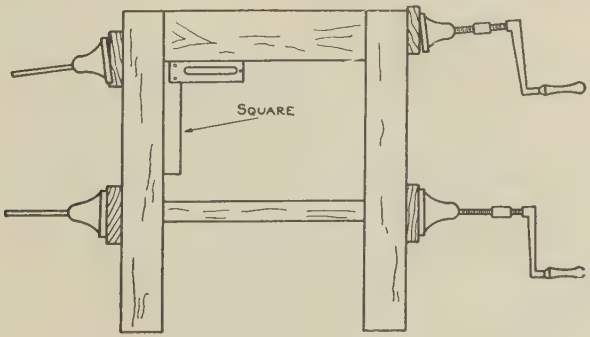


Fig. 221. Shifting a clamp as above sometimes is necessary in squaring a frame

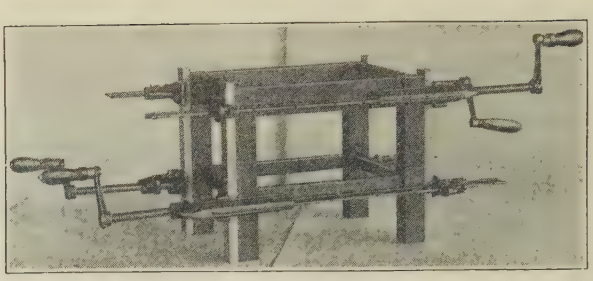


Fig. 222. Clamping a complete frame

rails, and four stretchers, should be assembled in two operations. Glue and clamp the two ends, or the two sides, first, in separate sections. See that each section is perfectly square before putting it away to dry. A slight readjustment of the clamps either in alignment (Fig. 221), or pressure, may be necessary to square up the part. Lastly, glue, clamp, and square up the complete frame. (Fig. 222.) A temporary brace (Fig. 223) across the diagonal will aid in squaring a frame when it is being clamped. Figure 224 shows a handmade arrangement for clamping stock, when bar clamps are not available. The wedges exert the pressure.

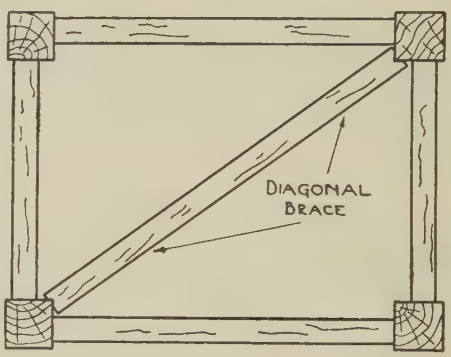


Fig. 223. A temporary brace of proper length will aid in squaring up a frame

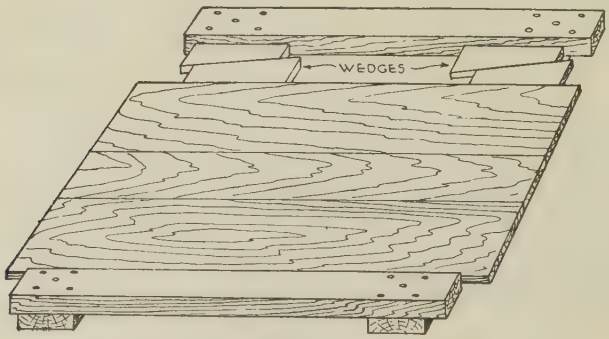


Fig. 224. A handmade arrangement for clamping stock edge to edge

PROCEDURE B: To Clamp with Hand Screws

Wood hand screws are the oldest form of clamps. They consist of two heavy wooden jaws, connected with two spindles (screws). (Fig. 225.) The spindles, formerly made of wood in the older types, can now be obtained in steel. The adjustable hand screw shown in Figure 216 can be adjusted to different angles for clamping, instead of always having the jaws parallel. This is accomplished by the swivel attachment of the spindle to the jaws. The illustration shows some of the advantages of this screw.

Hand screws may be obtained in sizes from a 3-in. opening of the jaws to a 14-in. opening. Hand screws are used mainly in gluing stock face to face and to hold stock or projects to the bench while work is being done on them. See Figures 226, 227, and 324 for the use of the hand screw.

To adjust a hand screw, grasp both handles firmly, and revolve about the shoulder or middle spindle. Revolve in one direction to open, and in the opposite direction to close.

To clamp with a hand screw, tighten the shoulder spindle (middle spindle) first, and then the back or end spindle. To open or release the screw, reverse the order. To clamp properly, the jaws should be parallel to the surfaces clamped. (Fig. 216.) Oil the jaws with linseed oil to keep glue from sticking to them. Allow the oil to dry thoroughly before using to prevent getting any oil on the work being clamped, thus interfering with the finish. Oil the steel spindles frequently with machine oil, for easy operation.

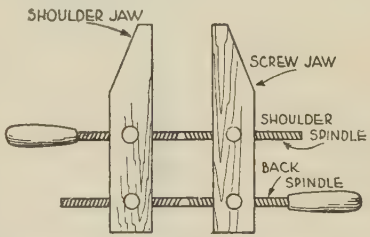


Fig. 225. Names of the parts of a hand screw

PROCEDURE C: To Clamp with Screw Clamps

Screw clamps are made entirely of iron and steel. A very small-size screw clamp with a 2¼-in. opening is called a quilt-frame clamp. The larger sizes up to a 12-in. opening, are useful for general clamping. In finished work, wood blocks are always necessary to protect the surface. (Fig. 228.) The screw clamp is used in situations similar to those in which the hand screw is used. It is quite useful in many types of repairwork. (Fig. 229.) It is also convenient for clamping together several pieces when laying out duplicate joints. (Fig. 230.)

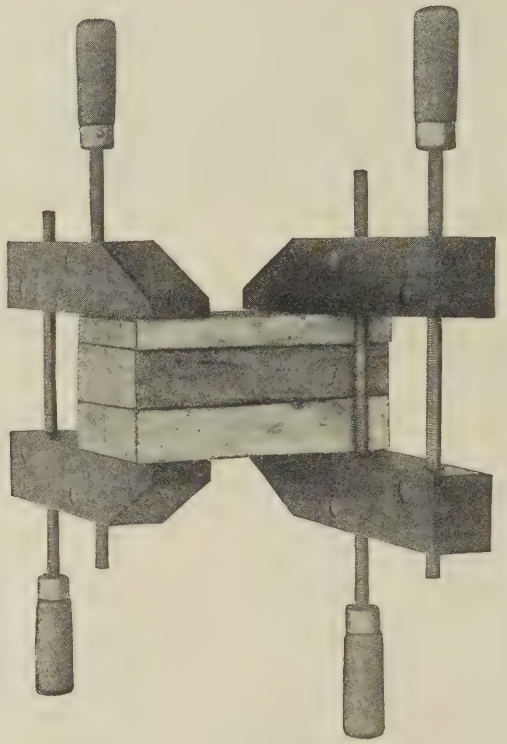


Fig. 226. Hand screws used in gluing stock face to face

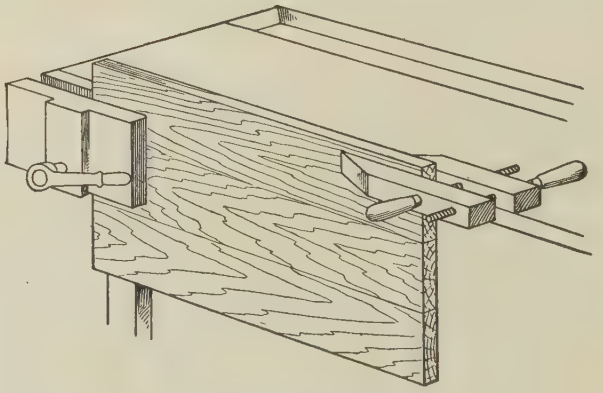


Fig. 227. Hand screw used to support a wide piece for jointing an edge

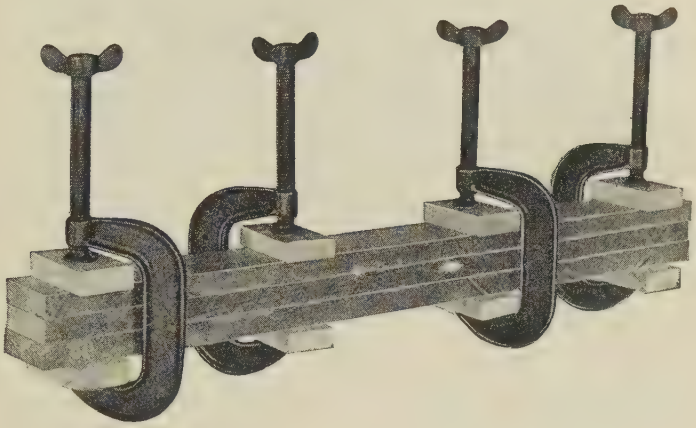


Fig. 228. Clamping stock face to face with screw clamps

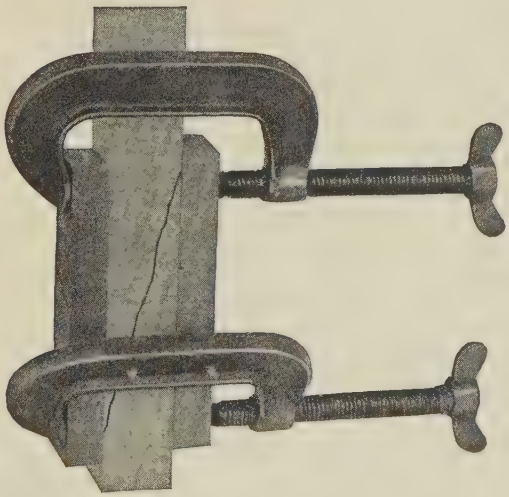


Fig. 229. Screw clamps used in gluing a broken leg

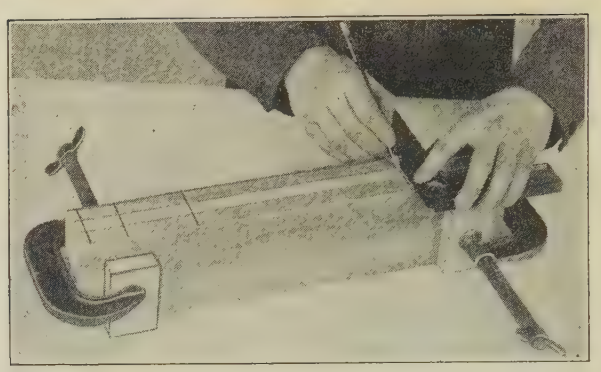


Fig. 230. Screw clamps are used for temporary clamping when laying out duplicate joints on several pieces

QUESTIONS:

1. What is clamping?
2. What is the object of clamping?
3. Is the vise a clamp? Why?
4. What is the use of the screw on clamps?
5. What clamps are used for thin pieces?
6. Name two common clamps.
7. What is the use of the bar clamp?
8. What is the general procedure in clamping?
9. What is the object of blocks under the jaws of a clamp?
10. What kind of clamps are the longest?
11. How are bar clamps adjusted?
12. In what lengths can bar clamps be obtained?
13. How should the clamps be arranged in gluing stock edge to edge? Why?
14. How hard should you turn the handle of a bar clamp?
15. How should the work be divided when gluing up a table?
16. What may be done with clamps to square up a frame?
17. How may stock be glued up without bar clamps?
18. Of what are the jaws of hand screws made?
19. What spindle is used to tighten a hand screw?
20. What is the advantage of putting linseed oil on the jaws of a hand screw?
21. How large a hand screw can be obtained?
22. How do you adjust the jaws of a hand screw?
23. How should the jaws of a hand screw be when the stock is properly clamped?
24. Of what are screw or C clamps made?
25. Why are they called C clamps?
26. What is a quilt-frame clamp?
27. Name three uses of the screw or C clamp?

UNIT 25

TO MIX AND APPLY THE COMMON GLUES

Glue is probably the oldest fastener used in woodwork. The Egyptians used glue as an adhesive for wood at least 3,000 years ago. Cabinets of the ancient Greeks and Romans, made with joints held together with glue, are still preserved in the museums of today.

There are a number of different kinds of glues. Those most commonly used in the average shop are the animal, casein, and cold liquid glues. Each has its advantages, since each glue possesses certain properties which make it valuable for certain purposes and types of construction. Animal glue possesses strength, casein glue is the most water resistant, and cold liquid glue is always ready for immediate use.

The following table (Fig. 231) shows interesting comparisons of the different kinds of glue commonly used.

Item of comparison	*Animal glue*	*Casein glue*	*Cold Liquid Glue*
Source	Hides, bones, skins, etc.	Casein of milk	Animal or fish parts
Area covered per lb.	25-35 sq. ft.	35-55 sq. ft.	No data
How mixed	Soaked in cold water and melted	Mixed with cold water by stirring	Ready-mixed
How applied	Warm—on warmed stock	Cold—on cold stock	Cold or warm
Water resistance	Low	High	Low
Shearing strength	Best grades stronger than any wood	Equal to medium grades of animal glue	Good grades equal to medium grades of animal glue
Chief shop uses	For joint work (not exposed to water)	For water resistant joint work	For repairwork and odd jobs

Fig. 231. Comparisons of the common glues

The procedures given here describe the mixing and application of hot animal glue and cold casein glue. Cold liquid glue comes ready-mixed, and its use is similar to the above glues. It can often be used to advantage for repairwork and odd jobs.

Use only the best grades of all glues. Follow the rules given in this unit for mixing and preparing glues. Practice economy by preparing small quantities at a time.

Tools: Glue pot; scales and weights; glue brush; paddle.

Material: Glue; clean, cold water.

PROCEDURE A: Hot Animal Glue

1. Arrange for a water-jacketed glue pot

Glue can be successfully heated in only one way and that is with a water-jacketed pot. The action of dry heat or direct steam is never recommended since such methods usually result in overheating the glue. A double boiler of the same principle used in the kitchen in the home is the standard method employed.

The handiest glue pot contains a water jacket and is electrically heated. An automatic switch controls the amount of current so that the proper temperature is maintained at all times. Such glue pots are made in small and large sizes (Fig. 232), and they are most convenient for the average shop.

In emergency cases, any double-boiler arrangement can be used. Get an ordinary enamel double boiler from the hardware store, or place any smaller vessel in a larger pan of water. Vessels made of copper, aluminum, or with a porcelain lining are the most satisfactory for the use of animal glue. They resist the acid action of the glue. For the best results, the inner pot should be covered while the glue is being melted. The cover is a protection against the evaporation of water which should be reduced to a minimum in glue preparation. Covers will prevent the formation of a skin or scum on the surface of the glue, and tend to reduce caking on the sides of the pot. Covers will also keep the glue clean.

Fig. 232. Covered electric glue pots can be obtained in various sizes

2. Select the grade of the glue

Specific grades of glue are made in order to accommodate the different classes of wood. The general grading in this case is for hard and soft woods. Another grading is with reference to the quality of the glue. The highest grade glues give more strength and are recommended for the most satisfactory work. Certified glues are tested and a guaranteed shearing strength is indicated. Figure 233 shows the method of one manufacturer for the grading of glues.

The different glues are furnished in either the flake or the powder form. Flake glues are in thin chips or strips, while the powders are the result of grinding. The advantage in the use of ground glue is that it need not be soaked so long.

3. Determine the amount of the glue

The amount of glue to be prepared depends upon the amount of gluing to be done. It is advisable to mix only the quantity needed for a day's job, since reheating of glue has a tendency to reduce its strength

Grade of glue	*Kind of wood (Physical classifications)*	*Proportions of glue and water (By weight)*		*Minimum shearing strength (Per sq. inch)*
		Glue	*Water*	
A	Hard	1 part	2 1/2 parts	2800 lb.
	Soft	1 part	2 parts	2800 lb.
B	Hard	1 part	2 parts	2600 lb.
	Soft	1 part	1 1/2 parts	2600 lb.
C	Hard	1 part	1 3/4 parts	2400 lb.
	Soft	1 part	1 1/4 parts	2400 lb.

Fig. 233. A table illustrating one manufacturer's recommendations for the preparation of his different grades of animal glue to secure maximum strength

and the evaporation of water makes the solution too thick. It is advisable to mix small quantities at a time, and thus have it fresh as required. Five ounces of dry glue mixed with 2½ parts of water by weight makes a pint of liquid, and this is sufficient for covering 8 to 10 sq. ft. of surface. Larger or smaller quantities of dry glue will give proportional amounts of liquid.

The proper way to measure the dry glue for mixing is to weigh it. No other method for the proportion of glue and water is as good as accurate weighing. Mixing glue according to dry measures, such as

Fig. 234. Weigh the glue and water for most satisfactory results in gluing

scoops, quart measures, buckets, etc., is not dependable, since flake glues may vary 100 per cent in bulk weight and ground glue 25 per cent. "Don't guess at the proportions of glue and water." "Glue should be weighed to determine the exact quantity." These are recommendations from several glue manufacturers. Weigh on a dependable scale the amount of glue desired. (Fig. 234.)

4. Weigh the water for soaking

Always soak the glue in clean cold water before melting (heating). Soft water should be used since the chemicals of hard water may injure the glue. The proper soaking of glue is considered one of the most important operations in glue preparation.

The proportional amount of water necessary for soaking any animal glue is determined by the grade of the glue and the work for which it is to be used. This proportion varies from 1¼ to 2½ parts of water by weight to 1 part of glue. Use the amount of water as recommended by the manufacturer of the glue, and weigh it for accurate results. The specifications in Figure 233, for three grades of glue manufactured by one glue company, illustrate the above.

5. Soak the glue in cold water

Soaking in cold water gets the glue into proper condition to dissolve readily when heat is applied. Soaking in warm water will not give satisfactory results. It is a good plan to add the glue to the water in small amounts, and stir thoroughly until all is uniformly mixed. This is especially important when mixing ground glue. This method keeps the glue from collecting in balls and thoroughly mixes it with the water.

Use only clean containers for soaking the glue. One manufacturer says, "This does not mean practically clean, but absolutely clean." The safest plan is to remove all the old glue from the pot and rinse with scalding-hot water.

The time for soaking the glue depends on the form. Ground glue will dissolve in from 30 minutes to 4 hours, according to the fineness of the powder. It is necessary to soak flake glues from 1 to 12 hours according to the thickness of the chips. To test if glue is properly soaked, remove some from the container and press it between the thumb and forefinger. If the glue is entirely squeezed from between the fingers, and the fingers come together and meet, it is thoroughly soaked.

6. Melt (heat) the glue

Melting the glue is also a very important operation in glue preparation. Temperatures higher than 150 deg. F. will begin to rapidly destroy the strength of the glue. Under no circumstances should you allow the glue solution to boil. The automatic electric heater will keep the glue at the right temperature. If only water vessels are available, a thermometer should be used to test the temperature.

A minimum of 120 deg. F. for glue is also essential. The binding strength of glue depends upon its penetration of the wood. Glue below 120 deg. F. will not penetrate since the body of the solution is too heavy for perfect fluidity. Therefore, underheating glue is to be avoided as much as overheating.

7. Heat the stock

Surfaces to be glued should be at a temperature of at least 75 to 90 deg. F. Colder stock will chill the glue with a result that it is impossible to spread the glue, and furthermore it will not penetrate into the pores

of the wood. It, therefore, is necessary to heat the wood to be joined if it is colder than 75 deg. F. Avoiding drafts in a glueroom will aid in keeping the stock and the glue warm.

8. Apply the glue

A glue brush should be used to spread glue by hand on outside surfaces. Apply a sufficient coating of glue to cover the surfaces well. A small wooden paddle can be used to advantage in applying glue to holes or mortises. The paddle is also useful for stirring the glue at intervals during use. When soaking a new batch of glue, the brush should be thoroughly washed out when the pot is clean.

In applying glue, be careful not to use too thick a solution. Glue must be thin to penetrate, and, as stated before, penetration is absolutely necessary for a successful joining. Fresh glue, properly proportioned by weight and heated to the right temperature, will have the right consistency. It would be well for the beginner to examine carefully such glue in order to note the proper consistency. The continual heating of glue tends to make the solution thicker. It should always run from the brush in a thin stream, and spread with ease. The thinning of melted glue with water impairs its strength, but the strength of a joint made with such glue of the proper consistency is far more than one made with a solution that is too thick.

9. Clamp the joint

Clamp the joint while the glue is hot. (See Units 24 and 26.) Proper clamping will insure good joining.

PROCEDURE B: Casein Glue

1. Determine the amount of the glue

Casein glues have slightly more spread than animal glues. (Fig. 231.) Plan to mix only enough glue for the immediate job. Manufacturers who have prepared casein glues always furnish special directions for mixing their product. Read and follow such directions carefully. The following directions are general for all casein glues.

2. Weigh the glue and water

It is important that you weigh the glue and water according to the proportions recommended by the manufacturers. A common proportion is 9 parts of water to 5 of glue. Only the proper mixture by weight will give the maximum strength.

3. Mix the glue and the water

Use a glass, china, or an enameled vessel for the mixing of casein glue. Galvanized iron will do in an emergency. The glue and water are always

mixed cold. Sift the glue into the water and mix thoroughly by stirring until the mixture is a uniform, creamy solution. A rotating egg beater will aid in securing a thorough mixture. In some cases, the mixture must set for a few minutes before application.

4. Apply the glue

Casein glue is applied cold, and it is readily spread with the brush. When casein glue is spread on wood, it does not thicken so quickly as animal glue. This allows more time for clamping.

5. Clamp the joint

The joint should be clamped while the glue is still wet. Excessive drying of the glue will decrease the strength of the joint. In most cases an allowance of 15 to 20 minutes can be made before the pressure need be applied. This is an advantage in using casein glue. Clamps can be removed in 4 to 6 hours.

QUESTIONS:

1. What is probably the oldest fastener of wood?
2. Name three kinds of glue.
3. From what is (*a*) animal, (*b*) casein, (*c*) cold liquid glue made?
4. What proof have we of the long use of glue?
5. What is the advantage of (*a*) animal glue, (*b*) casein glue, (*c*) cold liquid glue?
6. When is cold liquid glue used?
7. What kind of pot is recommended for heating animal glue?
8. What is the advantage of an electric glue pot?
9. How would you prepare glue properly without an electric glue pot?
10. Why should the glue pot be covered?
11. How are the animal glues graded?
12. Name two forms of animal glue?
13. What is the advantage of ground glue?
14. How much glue should be mixed at one time?
15. Why is it best not to reheat glue?
16. How should glue and water be measured for proportioning?
17. Why not use a scoop to measure out the dry glue?
18. What kind of water is used to soak glue?
19. When should more water be used in glue? When less?
20. How should glue and cold water be mixed?
21. What kind of vessels are best for soaking animal glue?
22. What should be done to all vessels before being used for glue?
23. How long should animal glue be soaked?
24. How can you tell when animal glue is properly soaked?
25. How hot can animal glue be heated?
26. Should animal glue be boiled?
27. What is the lowest temperature at which animal glue can be used?
28. How can you tell the proper temperature of animal glue?
29. Why heat the stock before applying animal glue?

30. What should be the temperature of the stock for applying animal glue?
31. Why avoid drafts in a glueroom?
32. How is glue usually applied by hand?
33. What is the use of a paddle in the glue pot?
34. Is it better to use glue too thin or too thick?
35. What grade of glue is best?
36. How can you determine the proper consistency of melted glue?
37. When should glue joints be clamped?
38. State how casein glue is mixed?
39. Where would casein glue be used?
40. State two advantages of casein glue.

UNIT 26

TO GLUE UP STOCK

It has been demonstrated that glue, if properly prepared and applied to joints that fit, is stronger than the wood itself.

It is often necessary to build up stock to secure greater width for table tops and the like. This is done by gluing the stock *edge to edge.* In fact, sometimes a wide board is ripped and glued together again, to prevent warping. Glued-up stock will hold its shape better than solid stock, as the tendency of one piece to warp is counteracted by the other. This is accomplished by alternating the heart and sap sides of the boards as shown by the yearly or annual rings. For best results, the pieces to be glued should not exceed 5 in. in width, and pieces 2 in. or more in width can be used to advantage. This gives an opportunity to use up narrow stock.

Stock of greater thickness is often required for legs, etc., and, therefore, it is glued *face to face.* Stock built up in this manner will hold its shape better. It is not as likely to check, and eliminates the necessity of carrying on hand so many different thicknesses. The two operations are very similar, and directions for both are included in this Unit.

Tools: Clamps; blocks; mallet; glue pot; glue brush.

Material: Glue; stock to be glued.

PROCEDURE A: To Glue Up Stock Edge to Edge

1. Select and prepare the glue

See Unit 25 for directions. If hot glue is to be used, start the preparation in time so that it will be ready when needed. If casein glue is to be used, note the special directions of the manufacturer.

2. Select and rough-plane (if necessary) the face sides

Select the best face of each piece. (See Unit 13.) This face should be true, to serve as a basis for jointing the edges. If surfaced stock is used, planing may not be necessary. Unsurfaced stock should be rough-planed so that the grain can be seen. Finish-planing should be done after the stock is glued. Note and mark the direction of the grain as you plane. Place arrows on the surface as in Figure 235, indicating the direction of the stroke for finish-planing. This gives the uphill direction of the grain, and will aid in the proper arrangement of the pieces.

3. Arrange the pieces (Fig. 235)

The pattern and direction of the grain and the direction of the annual rings are the factors considered for the arrangement of the pieces.

The grain (if possible) should go in the same direction as well as give a matched figure. This will make final planing easier and more successful since you will want to plane over each joint. The annual rings should be alternated; that is, they should curve in one direction on one piece, and in the opposite direction on the other. Note the annual rings at the ends of the boards and the final arrangement for gluing, in the illustration. Mark the joints as indicated when the arrangement has been made. These marks will be useful in jointing the edges and in assembling for gluing.

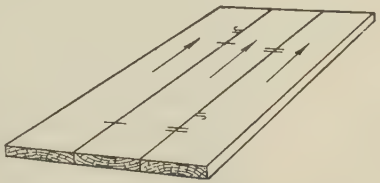


Fig. 235. Arrangement of pieces for gluing. Note (1) the direction of the grain indicated by the arrows; (2) the annual rings at the ends of the boards; (3) the method of numbering the joints

4. Joint the edges

Joint the edges (Unit 14) for one joint, and test as in Figure 236. Make sure that the ends are in contact. Glue joints will give way at the ends first, because the end grain is porous, allowing the wood to dry out and shrink. With long pieces, a slight amount of spring is often used in edge-to-edge gluing. Spring means a slight opening of the joint in the center. An opening equal to the thickness of newspaper will guarantee that the ends touch. Repeat the operations for remaining pieces, and see that the joints are numbered.

Fig. 236. Testing jointed edges to see if they fit properly

5. Make trial assembly

Clamp the pieces to see if the joints come together properly. Use a moderate amount of pressure on the clamps. Do not force them. Alternate the clamps above and below as in Figures 220 and 238. If the clamps are all placed on one side, the pieces may buckle and spring out. Have your work checked by the instructor. Place the clamps in a handy position for immediate use in actual gluing.

6. See that the glue is ready

7. Warm the stock

No warming is necessary for casein glue. If hot, animal glue is used, better results are obtained if the stock is warmed. Hot glue put on cold stock may thicken before the clamps can be applied, and a poor joint

result. Warming the stock makes the glue penetrate the wood, and allows more time for clamping before the glue sets.

8. Apply the glue

Before applying glue, have everything in readiness for the final operations. Set the clamps at the proper length and arrange so that you know the exact order of joining. Get someone to help you; it may be a two-man job. Work as fast as you can, especially when using hot glue. Apply a coat of glue to two or three edges at a time. (Fig. 237.) When possible, it is advisable to rub the joints to force out the surplus glue. When gluing many pieces, the rubbing may have to be omitted to save time in assembling. The following method of stacking and gluing is sometimes used: Stack the pieces for gluing, thus presenting only two sides of a stack on which to apply the glue. If there are five pieces and the first piece is nearest you, lay the fifth piece upside down on top of the first, and 4, 3, and 2 in succession right side up on top of the stack. Apply glue to the two sides of the stack and lay out in reverse order for clamping. Do not apply glue to the near edges of the first and fifth pieces.

Fig. 237. Applying glue to several edges at once will save time

9. Clamp the stock

Place the pieces in the bar clamps, as shown in Figure 238. Screw clamps and blocks may aid in aligning the joints at the ends. Paper placed under the blocks will prevent them from sticking to the stock. A mallet will help to even the joints in the middle. If hot glue is used, clamp the stock rapidly, especially if the glue is liable to chill. More clamping time is possible when casein glue is used. (See Unit 25.) Apply a moderate amount of pressure and put away to dry. It is well to allow 12 hours for drying before removing the clamps.

PROCEDURE B: To Glue Up Stock Face to Face

Select enough stock to give the desired thickness. Arrange the pieces so that the best grain will be on the two exposed surfaces. Alternate the

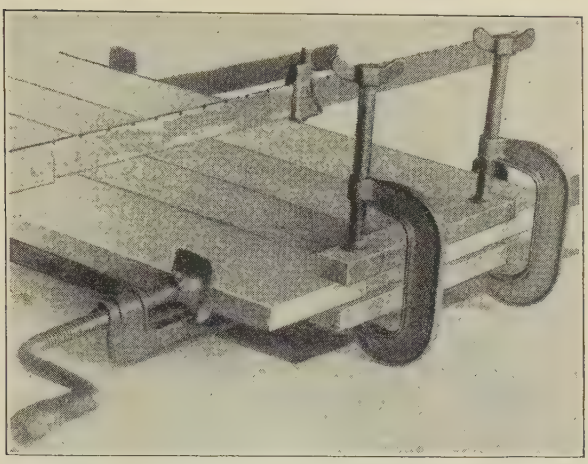


Fig. 238. Alternate the bar clamps. Screw clamps will aid in aligning the joints at the ends. Paper placed between the blocks and the stock being glued will prevent them from sticking

annual rings as in Figure 239. Mark the order of pieces, and true up the faces for the joints. Each surface should be straight and true throughout its entire length and width. Make sure the joints at the ends are well made. Do not plane the edges until the gluing is done. Make a trial assembly to see that the joints are good on both edges and both ends. The surplus glue should all be forced out when the stock is clamped. If the glue is too thick, a heavy glue line will be visible at the joint. Clamp the stock with screw clamps, as in Figure 240. If hand screws are used, make sure that the jaws are parallel to the surfaces clamped. (Fig. 241.) Proper clamping will insure good joints on both edges.

Fig. 239. Alternate the annual rings when gluing face to face

QUESTIONS:

1. Why is stock glued up?
2. Why is a wide board often ripped and then glued up?
3. What width pieces are used when stock is glued up edge to edge? Why?
4. Why is it advisable to begin the preparation of hot glue long before the stock is ready?
5. Why plane the face side before gluing edge to edge?
6. Should the face side be planed smooth before gluing edge to edge? Why?
7. Why note the direction of the grain in each piece?
8. Where can the annual rings be seen?
9. What have the annual rings to do with the arranging of the pieces?

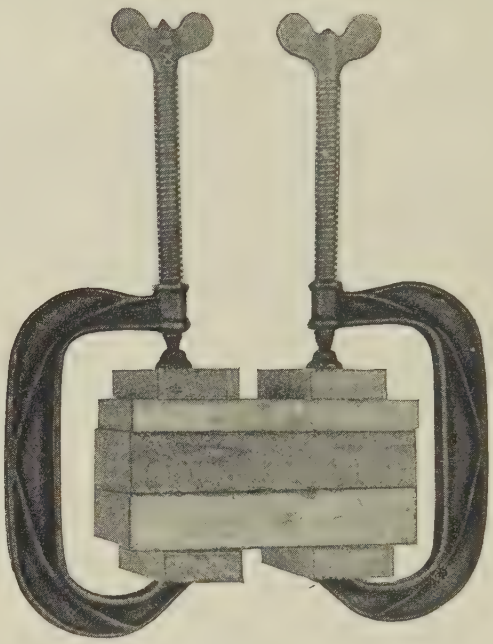


Fig. 240. Screw clamps used in gluing stock face to face

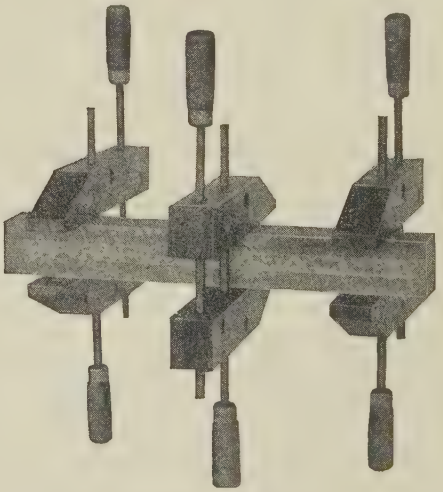


Fig. 241. Hand screws used in gluing stock face to face

10. What plane is best for jointing?
11. What is the advantage of slight spring in a joint?
12. Why should position of each piece be marked?
13. Why make a trial assembly?
14. How should the bar clamps be arranged on the stock?
15. Is it necessary to warm the stock when casein glue is used?
16. What is the advantage of warming the stock for hot glue?
17. Why apply glue to two or three pieces at a time?
18. Why have everything in readiness before starting to apply hot, animal glue?
19. State a method of stacking when gluing a number of pieces.
20. Why is a joint sometimes rubbed before clamping?
21. When should rubbing a joint be omitted?
22. Where could screw clamps be used in gluing up boards edge to edge?
23. What is the use of a mallet in gluing?
24. Why not use a hammer to even a joint?
25. How arrange the heart and sap sides of the pieces when gluing face to face? How is this accomplished?
26. Should the edges of the pieces be jointed before gluing face to face?
27. What will be the result of using glue that is too thick?
28. What clamps are used when gluing stock face to face?
29. Name two reasons for gluing up stock face to face.

UNIT 27

TO FASTEN A BUTT JOINT WITH NAILS

The butt joint is a common method used in joining pieces of wood. The pieces are butted together and then fastened with some type of fastener. Nails are the most common fasteners used in woodwork. Most nails are made of steel wire and are called "wire nails." Nails are made to suit almost every joint or purpose. It is interesting to note in catalogs the many kinds of nails that are made. The nails most commonly used are the common, box, casing, and finishing nails. (Fig. 242.) The corrugated fastener or "wiggle nail" (Fig. 247) is a special fastener adapted to certain types of construction and repair. The ability to drive nails is useful for the handy man around the home, office, or shop. Nails are usually driven with a claw hammer. (Fig. 243.)

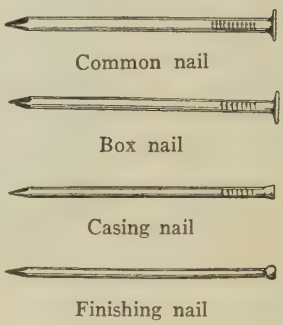


Fig. 242. The nails most commonly used. Note the heads and the different diameters

Tools: Hammer; nail set; hand or automatic drill.

Material: Stock for butt joints; nails; corrugated fasteners.

PROCEDURE:

1. Make and assemble the joint

Butt joints are usually made with the saw and plane. Square up the parts as in Unit 9. Clamp one piece in the vise, or support it on some solid object. It is easier to drive nails into a solid body than one that is loose or unstable. Put the piece to be fastened in its proper place, and check to see if the joint fits properly and is ready for nailing.

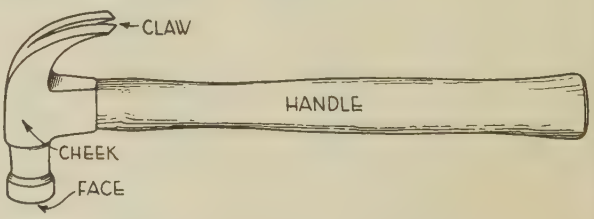


Fig. 243. Parts of a claw hammer

Penny Size	Length in Inches	Diameter in Thousandths of an Inch		
		Common	*Box and Casing*	*Finishing*
2d	1	.072	.067	.058
3d	1 1/4	.080	.076	.067
4d	1 1/2	.099	.080	.072
5d	1 3/4	.099	.080	.072
6d	2	.113	.099	.092
7d	2 1/4	.113	.099	.092
8d	2 1/2	.131	.113	.099
10d	3	.148	.128	.113
12d	3 1/4	.148	.128	.113
16d	3 1/2	.162	.135	.121
20d	4	.192	.148	.135

Fig. 244. Table showing penny size, length, and diameter of common, box, casing, and finishing nails as furnished by one manufacturer

2. Select the kind and size of nail

Common nails are used for large and rough work. They are especially adapted for use in carpentry. They are the largest in diameter and have large heads for strength. The length is given in pennys or inches. (See Fig. 244 for a table of the common lengths.) The larger common nails are called spikes. The length of a nail, whenever possible, should be at least three times the thickness of the piece to be fastened.

Box nails are similar to common nails but are more slender. They are used in box and carpentry construction where a heavier nail would split the stock. (See Fig. 244 for the common lengths.)

Fig. 245. Method of labeling common brads. The length is given in inches and the number indicates the wire gauge

Casing nails are used where a large head is objectionable. The head is small and can be easily set below the surface. They are used chiefly in blind-nailing flooring. The casing nail has the same diameter as the box nail. Casing nails are also obtained in the lengths given in Figure 244.

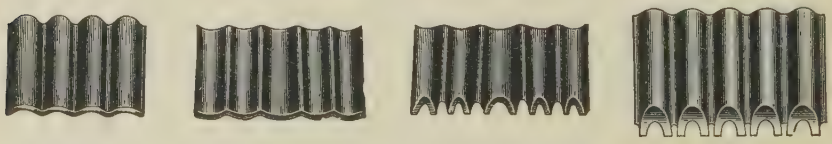
Finishing nails or wire brads are nails with small heads. They are used on all fine-finish work. Finishing nails can be obtained in the diameters and lengths given in Figure 244. Wire brads are furnished in numerous diameters in lengths from 3/16 to 3 in. The diameters are indicated by wire-gauge numbers. Figure 245 shows the method of labeling a box of brads. The table in Figure 246 shows the common gauge numbers of wide brads and the corresponding diameters in thousandths of an inch. Larger and smaller sizes can be obtained. It is well to note that the larger the gauge number, the smaller the diameter of the brad.

Flat-head nails of different diameters can also be obtained. The smaller diameters are useful for nailing thin stock. They are also furnished in diameters and lengths similar to wire brads. Experience has shown that lengths up to 1½ in. are very useful in the construction of bird houses and similar projects made of lumber less than 1 in. in thickness.

Wire Gauge Number	*Diameter in Thousandths of an Inch*
20	.035
19	.041
18	.048
17	.054
16	.063
15	.072
14	.080
13	.092
12	.106
11	.121
10	.135

Fig. 246. Table showing common gauge numbers of wire brads and the corresponding diameters as furnished by one manufacturer

Corrugated fasteners are sometimes called "wiggle nails." (Fig. 247.) They are used to fasten joints on the faces, making the joint very strong. This fastener is very useful in repairwork about the home. It can be used to tighten loose joints in screen doors, window sash, table tops, boxes, etc. Corrugated fasteners are made in plain and saw edges,



Parallel plain edge | Divergent plain edge | Divergent saw edge | Parallel saw edge

Fig. 247. Corrugated fasteners in two types and edges

and with parallel or divergent corrugations. The corrugated fastener with the divergent corrugations tends to draw the joint together as it is driven into place. The fastener with the saw edge is more easily driven into the wood. The length is measured parallel to the corrugations, and the number (size) equals the number of corrugations. The

common lengths are ¼ and ⅜ in., with 3, 4, 5, or 6 corrugations. They can also be obtained in other lengths.

3. Determine the number and position of the nails

It is well to plan the number and position of the nails for a joint. When a definite number has been decided upon, proper spacing can be made. System in nailing is much better than driving nails in a careless manner. Stagger the nails when possible (Fig. 248); that is, place the nails in different positions with reference to the grain of the wood. Do not drive several nails close together in the same grain as this may split the pieces. A smaller number of nails, correctly placed, will often produce a stronger joint. At corners, care must be taken so that nails will not come in contact with each other and thus split the wood. Note that there is a definite plan for nailing the joints in Figure 249.

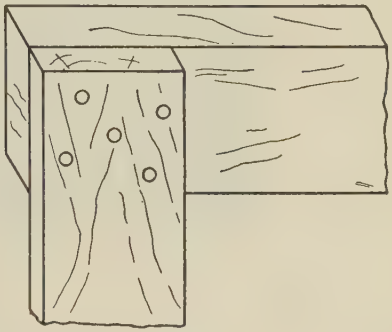


Fig. 248. Staggering nails with respect to the grain will help to prevent splitting and give a stronger joint

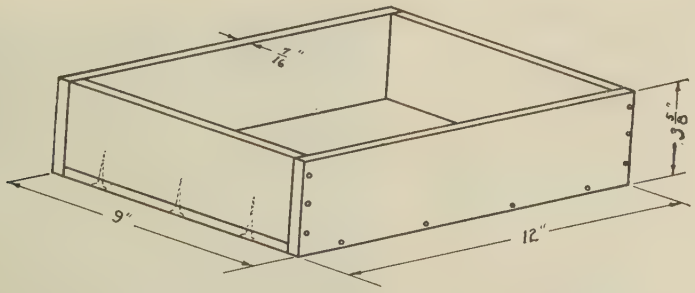


Fig. 249. A definite nailing plan is advisable for all joints

4. Determine the direction of driving the nails

Where maximum strength is desired, nails should be driven at an angle. (Fig. 250.) The slanting of nails helps to hold the joint more securely. Examine the joint from both sides to determine if slanting the nails is possible. Sometimes space will allow the nail to be driven only straight. Where appearance is essential, nails must be driven straight in order that the heads may be flush with the surface. When nails are driven in the direction as indicated in Figure 251, the operation is called "toenailing" and the joint (although a butt joint) is referred to as a toenail joint.

5. Start the nail

When starting to nail, stand in the direction of the line of nails. (Fig. 250.) This allows checking in the direction where the point of

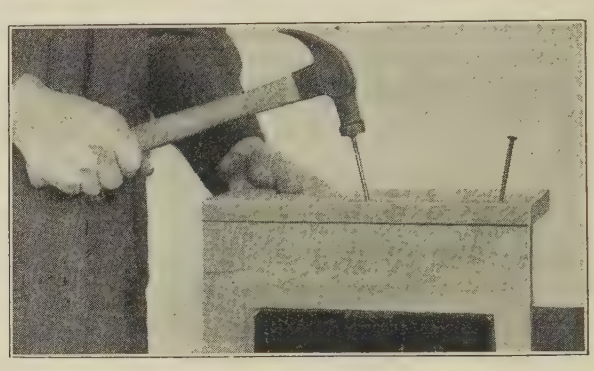


Fig. 250. Driving nails at an angle makes a stronger joint

the nail would most likely come out if the nail is not driven at the proper angle. Hold the nail in one hand, and the hammer in the other. Grasp the hammer handle firmly at the end. Steady the nail in the direction desired, and tap it lightly with the hammer. This starts

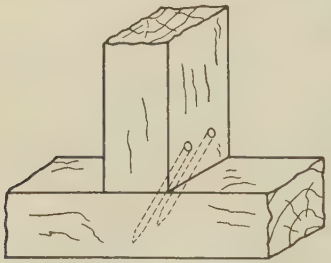


Fig. 251. Method of nailing a toenail joint

the nail, and determines the swing of the arm and wrist. If the nail is started in the proper direction, and the grain of the wood tends to bring the point out, slant the nail slightly in the opposite direction for a second starting. Do not attempt to change the direction of a nail by

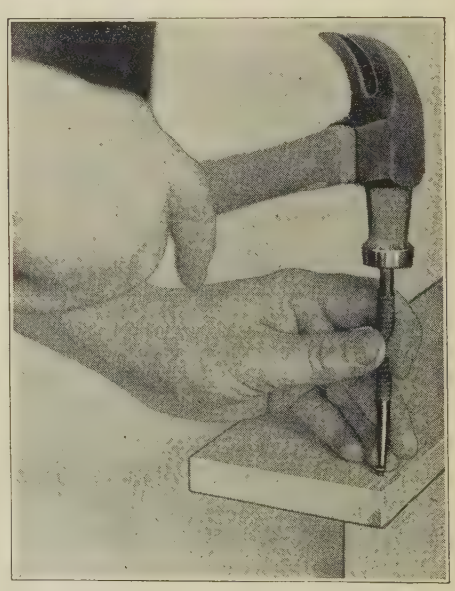


Fig. 252. Method of setting a nail with a nail set

pounding it sideways. This will only bend the nail and perhaps increase the chance of the point coming out and spoiling the joint. Pull out such a nail and start it in another place.

6. Drive the nail

In rough work, drive the nail with steady, hard blows until the head is flush with the surface. Hit the nail squarely with the hammer, using a free arm swing. One good blow after the head is flush, will draw the joint tight.

In finish work, take more care when driving nails. Be sure to hit the nail squarely on the head. Missing the nail, or a glancing blow, may bend the nail and mar the surface. Do not drive the nail all the way in. Use a nail set to drive the head slightly below the surface. (Fig. 252.) A finger resting against the head of the nail will aid in keeping the set in place when the blows are struck. Should the set jump off, it will probably do some damage.

When the nail is likely to split the stock, drill a hole with the hand or automatic drill. The drill size should be about two thirds to three fourths the diameter of the nail. When nailing in hard wood, beeswax or soap on the point of a nail will make driving easier.

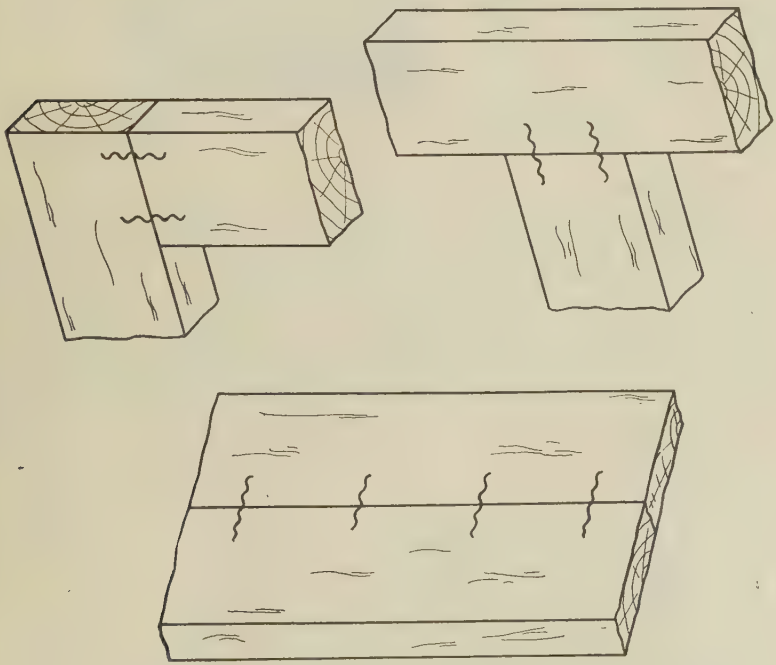


Fig. 253. Method of fastening common joints with corrugated fasteners

Corrugated fasteners also are driven with a hammer. Assemble the joint to be fastened and place it on a solid surface. It is important that the surface does not vibrate. Drive with medium heavy blows of the hammer. Strike at different places on the fastener to drive it evenly. Figure 253 illustrates some uses of the corrugated fastener.

7. Withdraw a nail

Nails are easily withdrawn with the claw of the hammer. (Fig. 254.) Place a block of wood under the hammer head to give additional leverage, otherwise the hammer handle may be broken in withdrawing a large nail. The block will also tend to keep the nail straight and protect the surface of the wood. If the nail is quite long, add a second or a thicker block.

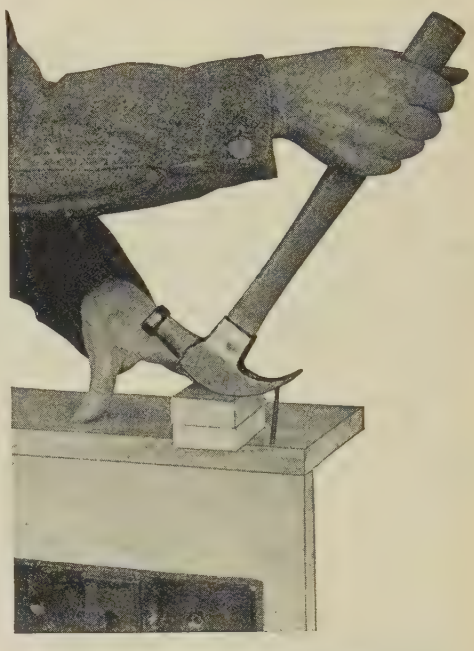


Fig. 254. Method of withdrawing a nail

8. Clinch a nail

Sometimes in rough work it is desired to nail together two thin pieces of board. Short nails will not give sufficient strength, so long nails are used and the points that come through are bent over or clinched. To clinch nails, strike the point from the side to bend it down. Set the clinch by placing the head preferably on a flat metal surface, and striking the bent end a direct blow. Clinching with the grain gives a smoother surface, while clinching across the grain makes a stronger and tighter joint.

QUESTIONS:

1. What is a butt joint?
2. How are butt joints often fastened?
3. What is a wire nail?
4. Name the nails most commonly used.
5. Name two other kinds of nails.
6. Why learn to drive nails?
7. What tools are used to make a butt joint?
8. Where are common nails used?

9. What is a spike?
10. How long is a 7-penny nail; a 10-penny nail?
11. How long should a nail be for fastening?
12. How do box nails differ from common nails? Why?
13. What is the use of a casing or finishing nail?
14. What is a brad?
15. State a use for small flathead nails.
16. Why is it best to plan the number of nails in a joint?
17. What is meant by "staggering nails"?
18. What precaution should be taken when nailing at a corner? Why?
19. Should nails be driven close together? Why?
20. What is the object in driving nails at an angle?
21. What is (*a*) toenailing; (*b*) toenail joint?
22. What might cause a nail to come out and split a board?
23. What should be done with a nail that has started in the wrong direction?
24. How should you stand when driving nails into the edge of a board?
25. When is a nail set used?
26. When do you drill holes for nails?
27. How large should the bit be when drilling for nails?
28. Why is beeswax or soap used on a nail?
29. For what is a corrugated fastener used?
30. What part of a hammer is used in withdrawing nails?
31. What is the purpose of a block in withdrawing nails?
32. When is a nail clinched?

UNIT 28

TO FASTEN A JOINT WITH SCREWS

Next to nails, screws are the most common fasteners used in woodwork. Setting screws requires more time and labor, but gives a stronger joint. Another advantage of the screw is the ease of taking apart and reassembling. Also, if the threads are not stripped in the pilot hole, a loose screw joint can be tightened by simply turning the screw.

Screws are made of mild steel (iron) or brass. The common types used for joining wood, are the flat head and the round head. (Fig. 255.) The flat-head screws are usually bright steel and the round-heads blued steel. The oval-head screw is often used to attach the common hardware to wood. All screws can be obtained in a nickle finish. With the exception of countersinking for flat-head screws, flat-head, round-head, and oval-head screws are set in the same manner.

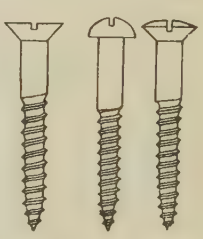


Fig. 255. Common screws used in woodwork

Tools: Screw driver; brace and bits; hand drill and bits; automatic drill; countersink; plug cutter; awl.

Material: Stock for project to be assembled with screws; screws; soap or beeswax.

PROCEDURE:

1. Determine the kind of screw to be used

Where a flush surface is desired, use a flat-head screw. On exposed surfaces, a round-head screw is sometimes preferred. Brass screws will corrode (rust) less than iron screws. A working drawing often indicates the kind of screws to use. R.H. means round head, F.H. means flat head. Hardware is often attached with oval-head screws.

2. Determine the diameter and length of the screw

The diameter of a screw is indicated by a number. Figure 256 shows the diameters and numbers of the screws in common use. Numbers 6, 8, 10, and 12 are used extensively in the average joints. If the working drawing does not specify the size, make your own selection.

In fastening, if possible, the screw should be twice as long as the stock is thick. Thin stock may alter this rule. Should the screw drive into end grain, at least three times the length of the stock thickness is recommended, if this is possible. Screws are made in lengths ranging from ¼ to 6 in. and in numbers from 0 to 24.

Gauge No. of Screw	*Diameter (Inches)*	*Shank Hole (All woods)*	*Pilot Hole*	
			Hard woods	*Soft woods*
2	.086	3/32	1/16	
3	.099	7/64	5/64	1/16
4	.112	1/8	3/32	5/64
5	.125	1/8	3/32	5/64
6	.138	9/64	7/64	3/32
7	.151	5/32	1/8	7/64
8	.164	11/64	9/64	1/8
9	.177	3/16	5/32	1/8
10	.190	13/64	11/64	9/64
11	.203	7/32	11/64	9/64
12	.216	15/64	3/16	5/32
14	.242	1/4	13/64	11/64
16	.268	9/32	15/64	13/64
18	.294	5/16	17/64	15/64
20	.320	21/64	9/32	1/4

Fig. 256. Table showing gauge number, diameter, shank-hole size for all woods, and pilot-hole sizes for hard woods and for soft woods, of the common screws

3. Drill hole for the shank (first hole)

Locate the position of the screws. Drill holes large enough so that the shank of the screw slips in easily. Select a bit, bore a hole in a scrap piece of stock and test, or refer to Figure 256 for the proper size. For the larger holes, use the brace and the bit-stock drill or auger bit. Use the hand drill or automatic drill for the smaller holes. When the piece in which the holes for the shank are to be bored is loose, or can be removed easily, remove it and bore entirely through the piece. When the piece is not removable, locate the position of the screws and, by using a depth gauge, bore the holes equal in depth to the thickness of the piece.

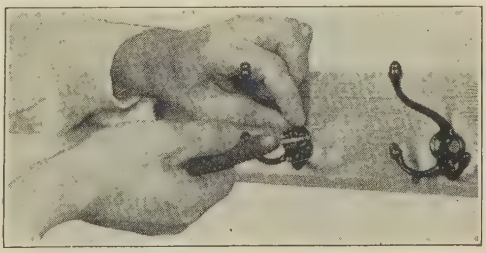


Fig. 257. Making a pilot hole with an awl

4. Drill the pilot hole (second hole)

The pilot hole should be directly beneath the hole for the shank and should be slightly smaller than the diameter of the shank of the screw. This allows the threads of the screw to securely engage in the wood. Figure 256 shows the recommended sizes of pilot holes for screws of the different diameters.

Hold the piece to be fastened securely in its proper place. Insert the bit in the shank hole, and bore the pilot hole. The combined depths of the shank and pilot holes should equal the length of the screw. If there is danger of boring through the bottom piece, use a depth gauge. The awl is often used for making pilot holes for attaching hardware to soft woods. (Fig. 257.)

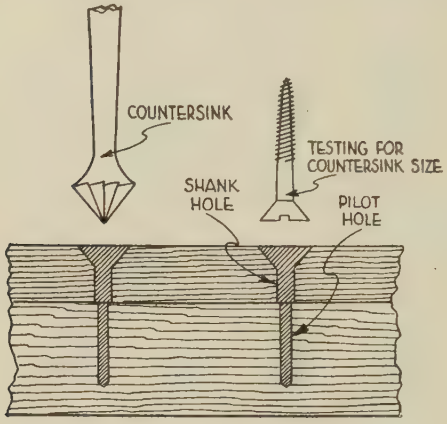


Fig. 258. Detail of making a joint with flat-head screws

5. Countersink for flat-head screws (only)

Place the countersink bit in a brace, and ream the hole as indicated in Figure 258. Test for proper size by turning the screw upside down and inserting it into the hole. The countersunk hole must be slightly

Fig. 259. A countersink with depth gauge attached

larger than the head of the screw so that the screw will be flush or slightly below the surface. When the proper size countersunk hole has been determined, a depth gauge (Fig. 259) will be found useful when a large number of screws of the same size must be set.

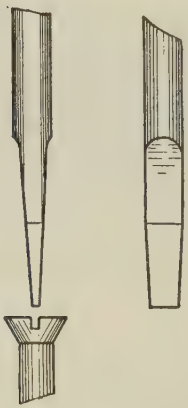


Fig. 260. Properly sharpened screw driver

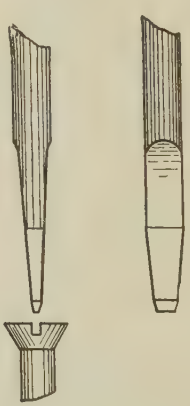


Fig. 261. Improperly sharpened screw driver

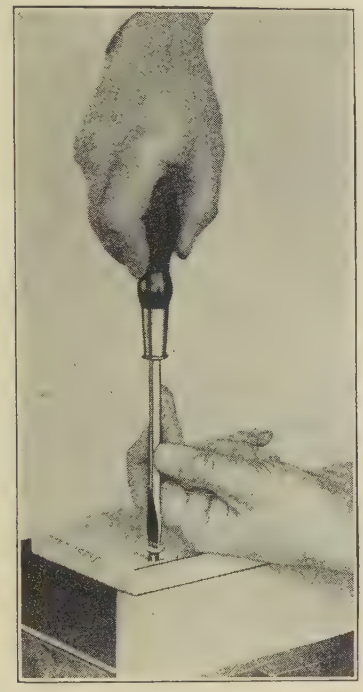


Fig. 262. Hold the screw driver firmly in the slot when driving a screw

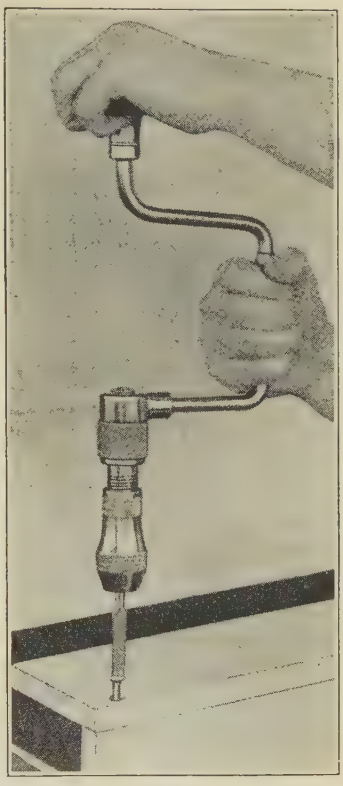


Fig. 263. Driving a screw with a screw-driver bit and brace

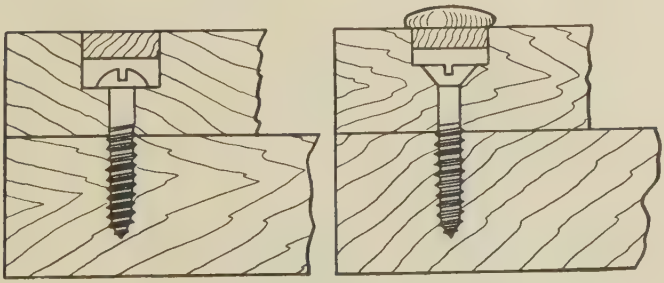


Fig. 264. Method of plugging a screw hole

6. Select a screw driver

Select a screw driver that fits snugly into the slot of the screw. The width of the bit should equal the length of the slot. Note the properly sharpened bit in Figure 260. An improperly sharpened bit (Fig. 261) will jump out of the slot, and damage the head of the screw or mar the surface of the project.

7. Drive the screw

Soap or beeswax on the threads of the screw will make it easier to drive. Hold the screw driver firmly in the slot. (Fig. 262.) This will prevent it from slipping as you turn the screw into place. Stop when the screw sets firmly. Further turning will strip the threads in the hole. The slots may be lined in one direction if desired. A screw-driver bit and brace is convenient for driving large screws. (Fig.263.)

8. Plug a screw hole

It is sometimes desired to entirely cover up the head of a screw. Figure 264 illustrates the method. Counterbore with an auger bit first, and then set the screw as directed above. Use a round or a flat-head screw. A flat-head screw will be better for thin stock. Cut a plug with a brace and plug cutter (Fig. 265), and glue it in the hole. Plane the surface if you desire it smooth. Figure 264 shows a round-headed plug that is not made flush with the surface. These plugs can be purchased at furniture supply houses, and are called "wood screw-hole plugs." (Fig. 266.)

Fig. 265. A plug cutter

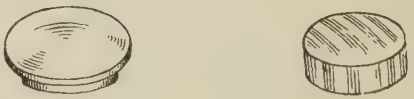


Fig. 266. Wood screw-hole plugs

QUESTIONS:

1. What ranks next to nails as fasteners?
2. What are the advantages of using screws?
3. What is a disadvantage in setting screws?
4. Of what materials are screws made?
5. Name two types of screws?
6. What is the advantage of each type?
7. What are the common finishes for screws?
8. What is the general use of the oval-head screw?
9. How is the diameter of a screw indicated?
10. How long should a screw be for a joint?
11. Screws are made in what lengths?
12. What should be the size of the hole for the shank of a screw? Why?

13. What should be the size of the pilot hole? Why?
14. What is a countersink?
15. How is a countersink operated?
16. What is the use of soap or beeswax on a screw?
17. What is the proper shape for a screw-driver bit? Why?
18. How is the head of a screw usually damaged?
19. Why take special care in driving screws in hard wood?
20. How can you hide a screw head?
21. What is a "wood screw-hole plug"?
22. How can you make a wood screw-hole plug?

UNIT 29

TO FASTEN A BUTT JOINT WITH DOWELS

Wood makes a very satisfactory fastener for the common joints. Before the general use of nails and screws, round wooden pegs (dowels) were used to hold the joints in place. (Fig. 267.) As a matter of fact, a dowel joint, when glued, is stronger than one that is nailed. It is, therefore, used extensively in furniture construction. It is a good substitute for the mortise-and-tenon joint, although not as strong. It is quite easily and accurately made, when a doweling jig is available.

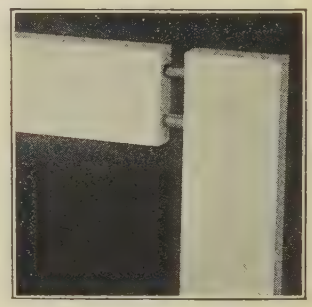


Fig. 267. A doweled joint ready for assembly

Dowels are usually made of hard, strong woods, such as maple or birch. They can be obtained from hardware supply companies at a reasonable price. They are furnished in 3-ft. lengths, and in diameters ranging from 3/16 to 1 in.. The sizes most generally used are 5/16 and ⅜ in. Dowel plates or machines are available, so that the dowels can be made in the shop if desired.

Tools: Plane; try-square; rule; knife; crosscutting saw; brace; bits; gauge; miter box; doweling jig; clamps; depth gauge.

Material: Stock for the joint or project; dowel rod; glue.

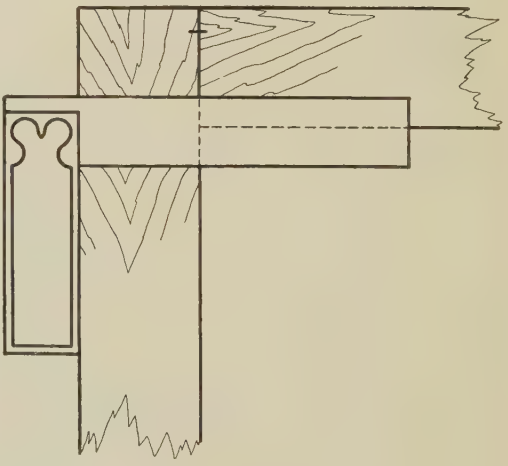


Fig. 268. Locating desired dowels on the face side of the stock

PROCEDURE:

1. Make the joint

Plane the surfaces or edges true. Make the saw cuts in a miter box and do not attempt to

plane the ends. With proper jointing and sawing, such a joint will fit perfectly. Assemble the joint, and check carefully for proper fitting before starting to lay out for the dowels.

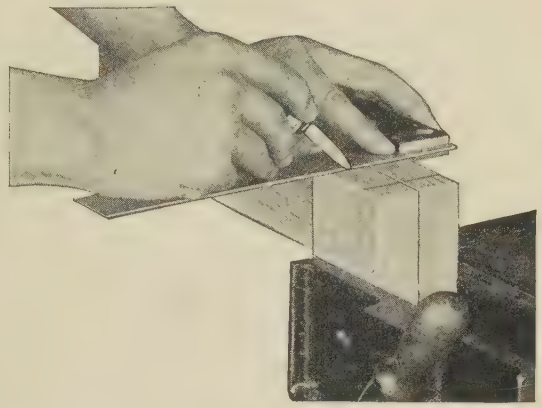


Fig. 269. Locating dowels on the surfaces joined

2. Lay out for the dowels

In frame construction, assemble the joint as in Figure 268, and mark the desired location for each dowel. Turn the butting surfaces up, and clamp them flush with each other in the vise. Square lines across the two butting surfaces with a try-square and knife. (Fig. 269.) This will accurately locate the spacing of the dowels equally on both pieces. If the holes are to be bored by hand, gauge from the face side of each piece (Fig. 270) to locate the alignment at right angles. Use a scratch awl to mark accurately the center of each hole. If a doweling jig is used, it will not be necessary to gauge a line, as the cylinder guide of the jig can be adjusted to center the bit by means of the graduations.

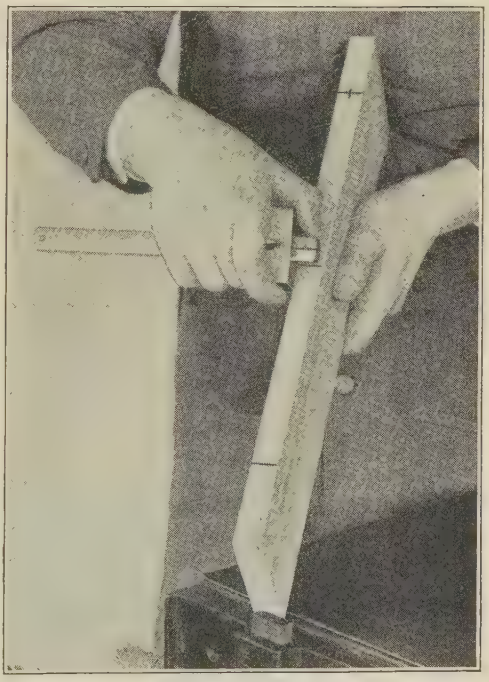


Fig. 270. Gauge from the face side to locate the position of the dowels

Should it be desirable to use dowels in gluing up stock edge to edge, the dowels are located as shown in Figures 270 and 271.

Figure 272 shows a method of laying out for

the dowel joint of a table or a stool. The thin piece is the rail and the square piece is the leg. Locate, with gauge and square, the position of the dowels on the end of the rail. Gauge for the line of dowels on the leg, then hold the rail on the leg as shown, and locate the spacing of the dowels with an awl or sharp pencil. If desired, the marking gauge only may be used to locate the dowels. (Fig. 273.) After the lines on which the dowels are to be placed are located, gauge from the top of the leg and the top of the rail to space the dowels on the line.

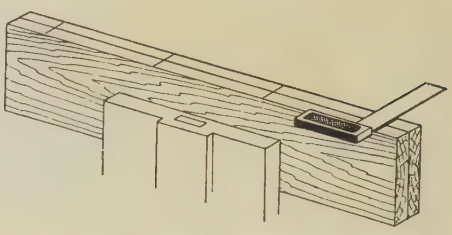


Fig. 271. Locating dowels when gluing edge to edge. Gauge or use doweling jig to locate the centers of each piece

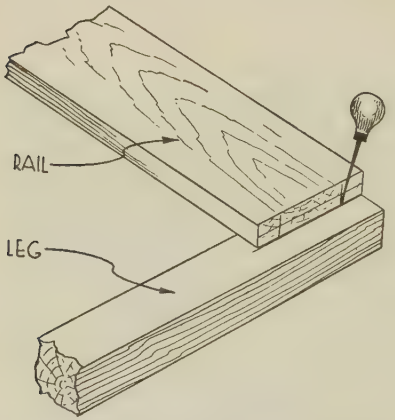


Fig. 272. A method of locating dowels on a rail and leg

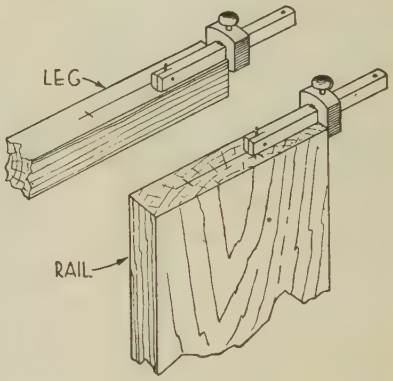


Fig. 273. The marking gauge is sometimes used to locate dowels on a rail and leg

3. Select proper-size dowel

The size of the dowel rod is determined by the thickness of the stock used in the joint. Usually 5/16- or ⅜-in. dowels are used in surfaced 1-in. stock.

4. Bore the holes for the dowels

Select an auger bit equal to the size of the dowel rod. When boring, start the bit at the exact intersection of the lines. Bore perpendicular to the surfaces. This is most important to keep the dowels in alignment. Figure 274 shows some of the ill effects of bad alignment. Use

DAN JONES - 55

a doweling jig if one is available. (Fig. 275.) Always set the jig from the face side of the stock. Countersink the holes a slight amount to remove the sharp arris. The holes should be about 1 in. deep, if the stock permits. A depth gauge gives uniform depth for all holes.

5. Prepare the dowels

Cut the dowels ⅛ in. shorter than the combined depth of the two holes. Point them slightly with a knife. The dowels should not fit too tightly, because a tight dowel will not leave sufficient glue around it to make a strong joint. A dowel fits properly when it can be inserted with pressure applied by the hand. Cut a V groove or saw cut 1/16-in. deep on the side of the dowel its full length. This will allow glue and air to escape from the bottom of the hole which might otherwise split the wood. Dowels are made and sold with grooves already cut, and are well worth the slight additional cost.

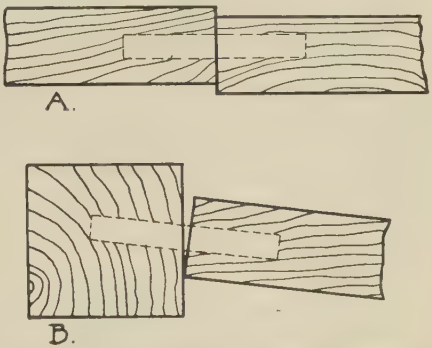


Fig. 274. A, dowels not properly centered; B, dowel hole not perpendicular

6. Make trial assembly

Assemble the joint or joints, and have the instructor check your work before gluing. Should a dowel hole be out of alignment (Fig. 274), glue in a piece of dowel rod, and when the glue has set, rebore in the proper place.

7. Glue the joint or joints

See Unit 26 for instructions on gluing. Apply a thin coat of glue to the holes, dowels, and the entire joint. Assemble and clamp securely. (See Unit 24.) Test for squareness or uniformity, and set away to dry. Clamp a frame, as in Figure 219.

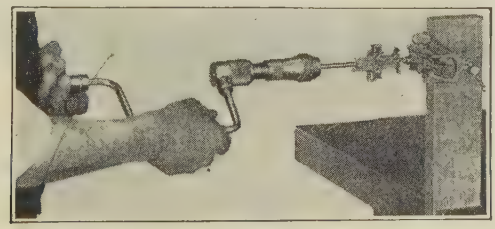


Fig. 275. Using a doweling jig and depth gauge simplifies the making of a dowel joint

QUESTIONS:

1. What is a dowel?
2. How strong is a dowel joint compared to a nailed joint; a mortise-and-tenon joint?
3. Where is the dowel joint used?
4. Dowel rod is usually made from what woods? Why?
5. What sizes of dowel rod can you buy?
6. What sizes of dowel rod are generally used?
7. What type of joint is usually doweled?
8. Why be so accurate in laying out for dowels?
9. What is the advantage of a doweling jig?
10. Why have the dowel holes in proper alignment?
11. How long should a dowel be?
12. How can you tell when a dowel fits properly?
13. What is the use of a groove in a dowel?
14. Why make a trial assembly before gluing a dowel joint?
15. If dowel holes are not in proper alignment, how could you repair the difficulty?

SUGGESTED JOINTS:

1. See Figure 276.

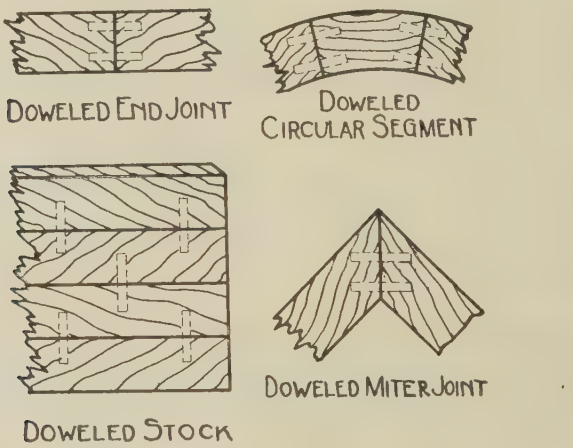


Fig. 276. Suggested uses of the dowel joint

UNIT 30

TO MAKE AND FASTEN A MITER JOINT

A miter joint is a butt joint which has been cut at an angle of 45 degrees. Miter joints are used extensively in construction. Many frames require mitered joints. A miter joint can be laid out and cut on rectangular stock without the use of a miter box. However, stock with curved edges or surfaces requires the use of the miter box. In any case, the miter joint can be made more quickly and more accurately when a miter box is used. A metal miter box will give the best results, but a handmade box, if well constructed, will serve the purpose. A number of methods may be employed for fastening the joint. Nails, nails and glue, and corrugated fasteners are generally used.

Tools: Rule; knife; pencil; try-square; back or panel saw; miter box.

Material: Stock or molding to be mitered.

PROCEDURE:

1. Select or make a miter box

A miter box is generally used to saw a miter joint. The use of a box gives a much more accurate cut. This is very essential in the making of frames, where four miter joints are necessary.

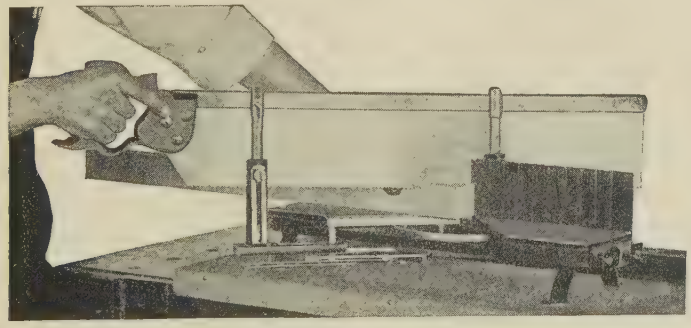


Fig. 277. A metal miter box makes a very accurate joint

The average shop has a steel miter box which does very accurate work. (Fig. 277.) Such boxes will cut angles from 30 to 90 degrees, and can be obtained in large and small sizes. They have special catches with an automatic release for holding and starting the saw.

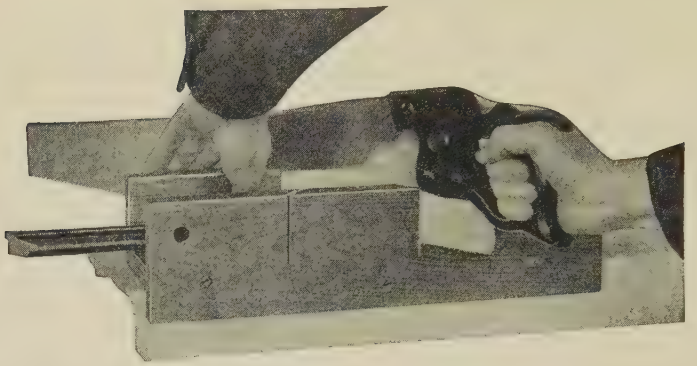


Fig. 278. A wooden box will serve if a metal miter box is not available

A graduated arc tells the angle of the cut, and adjustable stops are available for duplicating pieces of the same length and cut.

A wooden miter box made of hard wood (Fig. 278) is a good substitute, however. Every shop can have one, and it also would be handy in the home. Figure 279 gives the detailed dimensions for a medium-size box. Note that the distance between the lines for the miter cuts on the side of the box is equal to the over-all width of the box. This is necessary to produce an angle of 45 degrees, or the angle of a miter joint. The projection of the one side below the bottom will aid in holding the box on the bench when sawing. The square cut at the end allows stock to be sawed at right angles. Use a sharp, fine-point crosscutting or panel saw in the wooden box.

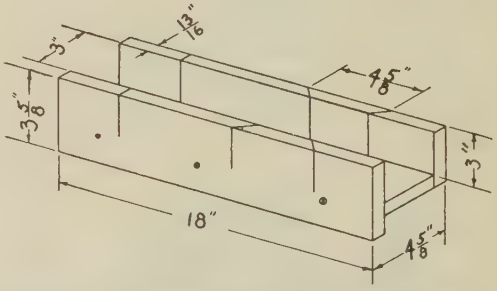


Fig. 279. A wooden miter box of medium size

2. Layout for the cut

If a miter box is used, the accurate length of the piece is all that is needed, since the miter box will determine the angle. Use a knife and rule, and locate the length (Fig. 280) on the arris that will be on top and away from you as the piece is placed in the miter box. On rabbeted stock, such as picture frames and the like, this length is determined by adding to the dimensions of the glass or picture twice the width of the molding on the rabbeted side. If the piece is not rabbeted, add twice the total width of the molding to determine

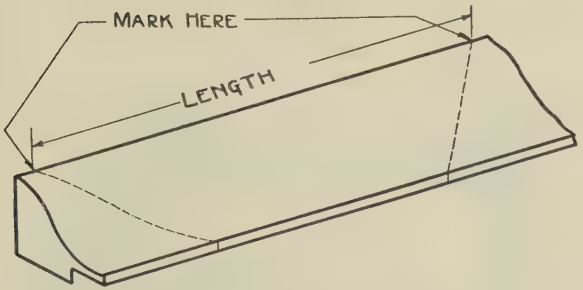


Fig. 280. Method of marking the length of a piece of molding to be cut in a miter box

the length. The length must be laid out accurately, since the *opposite* members in a mitered frame must be exactly equal, otherwise the joints will not fit properly. When several short pieces of the same length are to be cut, set the adjustable stop of the metal miter box at the exact length of the first piece. This will eliminate the necessity

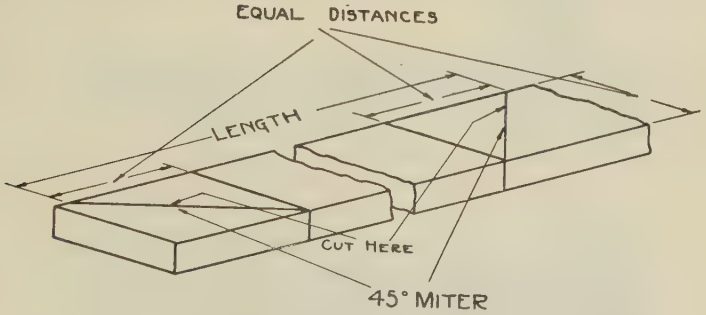


Fig. 281. Method of laying out for cutting a miter by hand

of laying out the length of each piece; it will save time, and more accurate work will result.

If the joint is to be cut by hand without the use of a miter box, it will be necessary to lay out the angle of the cut in addition to the length. Lay out the length as above. To lay out the angle, measure back from the mark a distance equal to the width of the piece. Square a line across the surface and draw the diagonal. (Fig. 281.) Then square lines on both edges from the ends of the diagonal to aid in sawing perpendicularly.

3. Saw the miter

If the joint is sawed without the aid of a miter box, saw to the line in the waste stock. If a miter box is to be used, place the stock in the box with the mark up and toward the outside of the box.

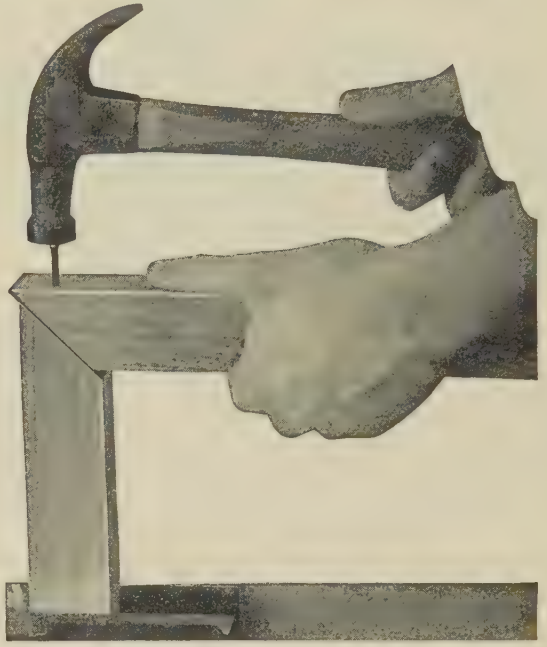


Fig. 282. If a miter joint cannot be clamped securely, allow for slippage when nailing

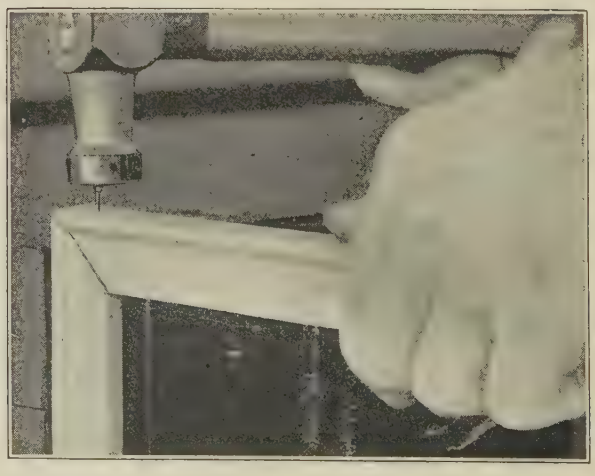


Fig. 283. Method of clamping and nailing a picture-frame joint in a common vise

Bring the saw down and adjust the piece until the saw just touches the mark. Saw in the waste part of the piece. Hold the stock firmly with the thumb toward the opposite side as you saw. Saw with slow, uniform strokes until the piece is entirely cut in two. At no time should you release the pressure of the thumb during the sawing, as this may allow the piece to slip. A movement of the piece will give an imperfect cut.

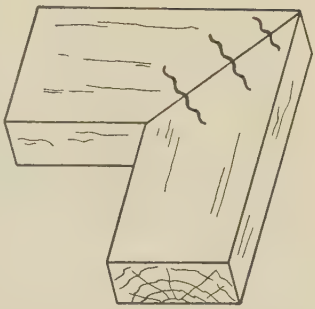


Fig. 284. Corrugated fasteners hold a miter joint securely

4. Fasten the joint

Nails, or nails and glue are often used to fasten a mitered joint. If the joint cannot be clamped securely for nailing, allow for slippage. (Fig. 282.) Nailing will tend to bring the joint in place. The vise can be used successfully for nailing a picture-frame joint. (Fig. 283.) When nailing a joint from both sides, place the nails so they will not strike each other and split the pieces.

The corrugated fasteners hold a miter joint very securely (Fig. 284.) Drive as directed in Unit 27.

Dowels with glue are also used for fastening a miter joint (Fig. 285*a*.) Lay out, bore the holes, and set the dowels as given in Unit 29. Triangular blocks glued on the frame will aid in clamping a frame. (Fig. 285*b*.) Remove the blocks when the joint is dry.

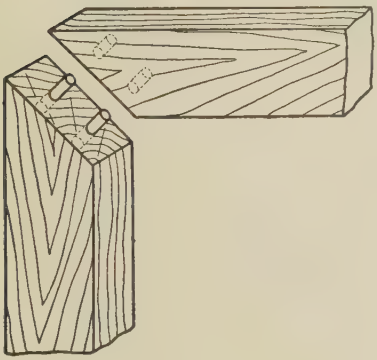


Fig. 285*a*. Dowels and glue are sometimes used for fastening a miter joint

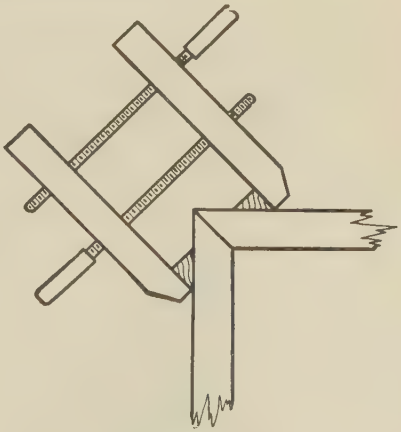


Fig. 285*b*. Triangular blocks may be glued on as a footing for clamps when glue is used as a fastener. The blocks are chiseled off and the surface planed and scraped when the joint is dry

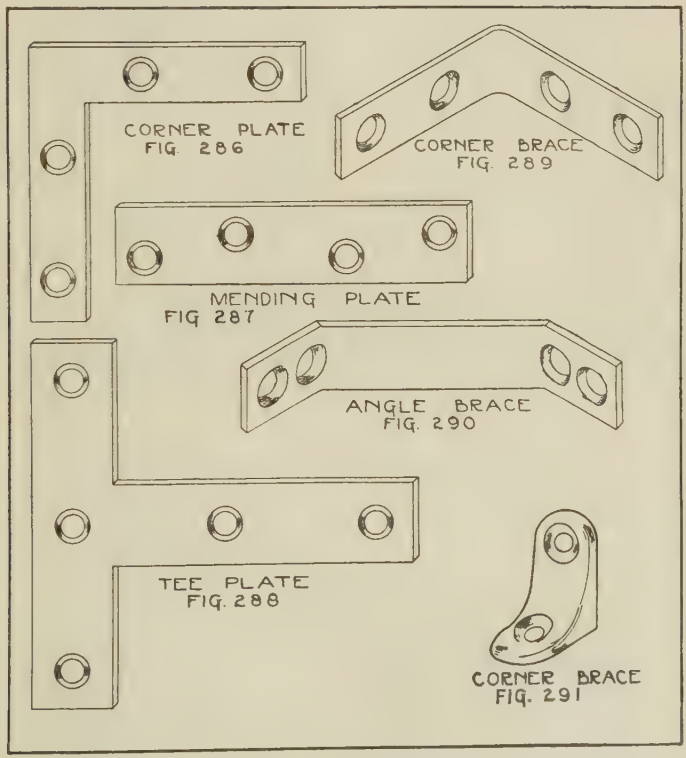
QUESTIONS:

1. What is a miter joint?
2. Where are miter joints used?
3. What is a miter box?
4. What is the advantage in its use?
5. What size of angles can be cut in a metal miter box?
6. What is the use of the adjustable stops on a metal miter box?
7. When a miter box is used, what laying out is necessary?
8. Why must the opposite members of a rectangular mitered frame be the same length?
9. When a miter joint is to be cut by hand, what layout is necessary?
10. What angle is a common miter joint?
11. How is the angle laid out?
12. What precautions should be taken when sawing in a miter box?
13. Name several methods of fastening a miter joint.
14. When do you make allowance for slippage when nailing a miter joint?
15. What is the advantage of a mitered joint in comparison with a square butt joint?

UNIT 31

TO STRENGTHEN OR FASTEN A JOINT WITH PLATES OR BRACES

The joints are often the weakest part in any project. When new, the joints are tight and solid, but after a period of service they sometimes become loose. Should the joints of chairs, stools, and tables become the least bit loose, the object becomes wobbly and usually falls to pieces. If the joints in a door or screen pull away, the door will sag and bind as a result. Plates and braces made of steel are especially designed to strengthen and brace such joints. Such plates and braces are



Figs. 286 to 291. Plates and braces used for fastening and strengthening joints

very useful for repair, but if attached when the joint is made, they tend to keep it tight and strong. They can be attached beneath a chair or table and thus will not be visible. Such braces are often used as regular fasteners for table tops, stool tops, etc.

Tools: Screw driver; hand or automatic drill.

Material: Joints to be braced; plates and braces; screws to fit.

PROCEDURE:

1. Note the different types of plates and braces

Figures 286 to 291 show some of the different types of plates and braces that are used for fastening and strengthening joints. These can be obtained at the hardware stores in different sizes. Many other types are made to fit special places and special joints. See hardware catalogs for other models.

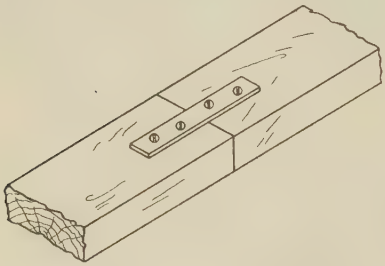


Fig. 292. End joint strengthened with mending plate

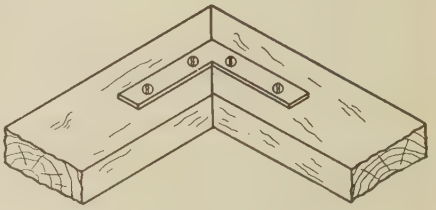


Fig. 293. Corner plate attached to a miter joint

2. Select a suitable type for the joint

Plates are used on the face of a joint. The common types are the mending plate, corner plate, and T plate. All are useful in strengthening the joints of doors, screens, sash, and frames of all kinds. The mending plate is useful where end grain is butted. (Fig. 292.) The corner plate is used at all corners (Fig. 293), and the T plate is attached where a center rail is joined. (Fig. 294.)

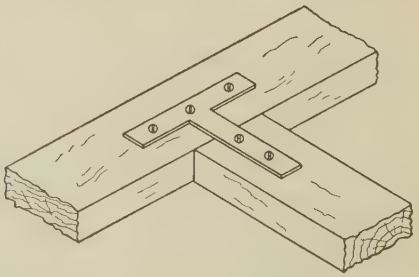


Fig. 294. Method of using a T plate

Braces are attached in the corners of the joint rather than on the face. (Figs. 295, 296, and 297.) They help to hold the joint together as well as to brace it. They are useful in bracing screens, frames, chairs, stools, and tables. The special table-top fastener, shown in Figure 298, slides back and forth in a groove, and allows for the expansion and contrac-

tion of the top. This type of fastener is particularly useful when the stock is not well seasoned.

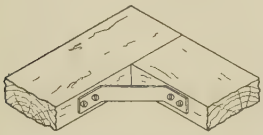


Fig. 295. An angle brace attached to a butt joint

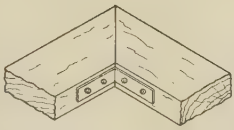


Fig. 296. A flat corner brace used to strengthen a miter joint

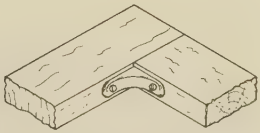


Fig. 297. A corner brace used to strengthen a butt joint

3. Select the screws

Flathead screws, as large in diameter as possible, are used to fasten plates and braces. The head of the screw should be flush or just below the surface. Place the screw in the hole, and test to see if it is flush. Get a length to suit the thickness of the stock.

4. Attach the plate or brace

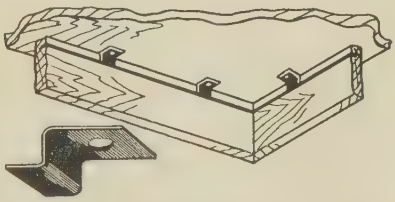


Fig. 298. A special table-top fastener

Place the plate or brace in its proper position, and drill pilot holes for the screws. (See Unit 28.) Mark the pilot holes, and remove the plate or brace for boring, or bore directly through the plate or brace into the wood. If the plate is not removed for boring, set one screw and check it to see if the plate or brace is in the proper place; then set the other screws. Be careful not to drill all the way through the wood, especially when attaching plates to thin stock.

QUESTIONS:

1. What is the object of attaching plates and braces?
2. Where is a plate attached; a brace?
3. Is it better to wait and brace a joint after it becomes loose, or to do it when it is new?
4. Where would you use the different plates?
5. Where did the T plate get its name?
6. Why attach braces to a chair or table leg?
7. What is the advantage in the use of the table-top fastener shown in Figure 298?
8. What kind of screws are commonly used to attach plates and braces? Why?
9. What should be (*a*) the diameter of the screw; (*b*) the length?
10. Why should a screw head not extend above the surface of a plate or brace?
11. What care should be taken in attaching a plate to thin stock?
12. How do you determine the size of the pilot holes for the screws?

UNIT 32

TO MAKE AND FASTEN A HALF-LAP JOINT

Half-lap joints, several types of which are shown in Figures 299, 300, and 301, are commonly used in woodwork. In the lap joint, as much stock is left in one piece as is removed in the other. When the two pieces are assembled, the surface is flush. Usually one half of the stock is removed from each piece making the half-lap joint. This makes a joint of the greatest strength. Half-lap joints are frequently used in the construction of screens and other frames. They are used in furniture making where two members cross each other, such as stretchers in taborets, partitions in drawers, trays, and the like. The carpenter makes lap joints on the sills and plates of buildings. The wide variation in lap joints necessitates also a variety of methods of fastening. Nails, corrugated fasteners, screws, and glue may be used. When well made and securely fastened, the half-lap joint is very serviceable.

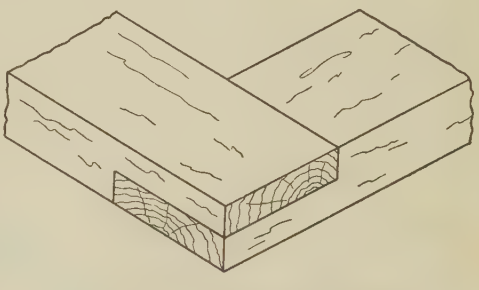


Fig. 299. A corner half-lap joint

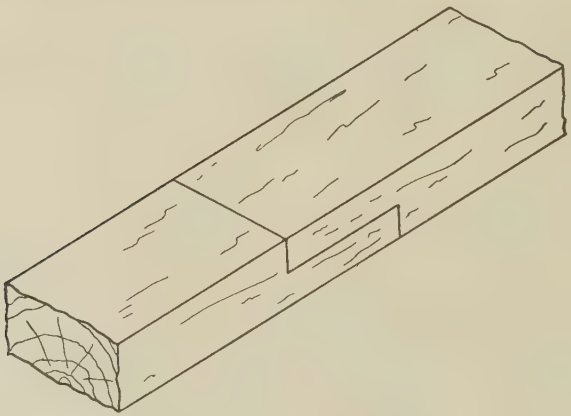


Fig. 300. An end half-lap joint

Tools: Rule; try-square; knife or pencil; gauge; screw clamp; saw; chisel; hammer; screw driver.

Material: Stock for the joint; nails; corrugated fasteners; screws; glue.

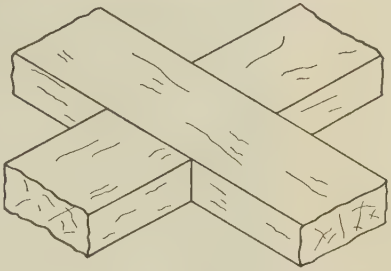


Fig. 301. A middle half-lap joint

PROCEDURE:

1. Square up the stock

See Unit 9. Make sure that the face side and joint edges are true. If the joint is to be made on the faces (Fig. 302), the pieces should be uniform in width, and if the joint is to be on the edges (Fig. 303), uniform thickness is essential.

2. Lay out the joint

Half-lap joints are all laid out in a similar manner. The directions given here are for a middle half-lap joint (Fig. 301), which is made at right angles on the face of the stock.

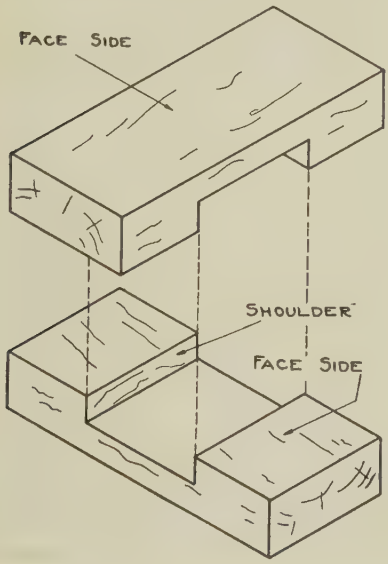


Fig. 302. Detail of a lap joint made on the faces

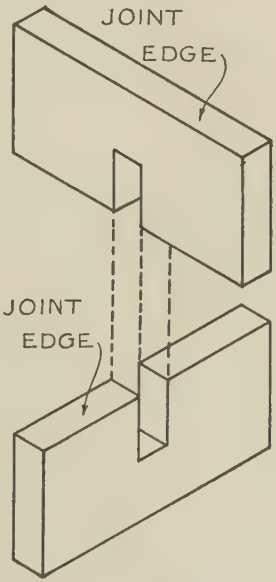


Fig. 303. Detail of a lap joint made on the edges

a) Locate the joint

Cut the stock from the face side on the bottom piece and from the surface opposite the face side on the top piece. (Fig. 302.) Locate the center of each piece. Square lines across the face at these points.

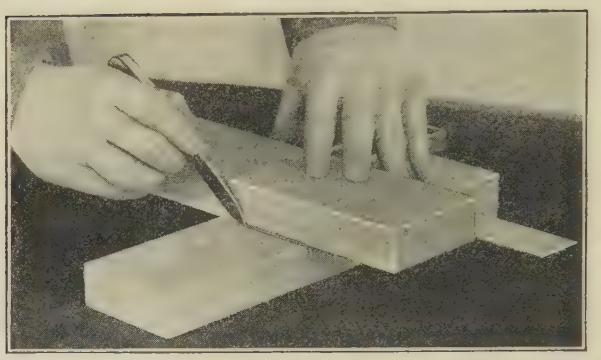


Fig. 304. Marking for the width of a half-lap joint

b) *Mark for the width of the cut*

Then, from the center, measure either to the right or to the left one half the width of each piece to locate one edge of the joint. Place one piece on top of the other so that one edge of each piece coincides with the line on the other. (Fig. 304.) A try-square will help to hold the pieces at the proper angle. Note the position of the face sides as indicated by the face marks. If it is found difficult to hold the pieces securely, a screw clamp may be used. Check by measurement to see if the joint is at the proper place. Draw the lines to give the layout for the exact width of the cut. (Fig. 304.) Should it be difficult to superimpose the pieces, lay out for the width of the cut by accurate measurement.

Fig. 305. Gauge for the depth of the cut from the face side

c) *Square lines on the edges*

Hold the handle of the try-square on the face side, and square lines on both edges of both pieces. The length of these lines equals one half of the thickness of the stock.

d) *Gauge for the depth of the cut*

Set the marking gauge at one half the thickness of the stock, and

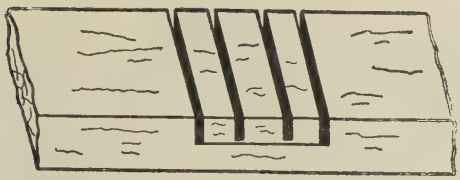


Fig. 306. End saw kerfs should be in the waste stock. Additional saw kerfs in between will aid in chiseling

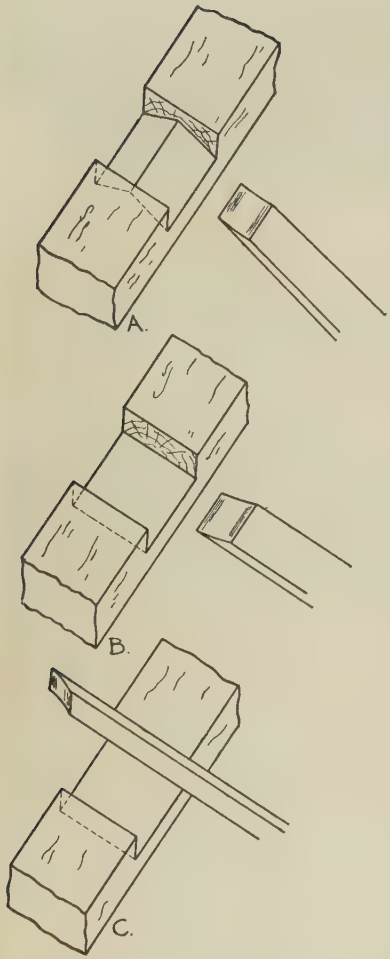


Fig. 307. Steps in chiseling a half-lap joint

always gauge from the face side. (Fig. 305.) By gauging from the face side on both members, the same amount of stock left in the top piece will be cut out of the bottom piece, and the face sides will be flush when the joint is assembled. Gauge on both edges of both pieces. Do not gauge past the lines on the edges. The gauge lines would be visible unless removed, and then the joint would not fit properly.

3. Saw the shoulders of the joint

Saw the sides or shoulders of the joint with a backsaw or a fine panel saw. Saw on the face side of the bottom piece and on the opposite face of the top piece. Saw in the waste stock to the line and just to the proper depth. (Fig. 306.) In wide joints, make several saw kerfs in the middle of the waste stock to aid in chiseling out the joint. In end or corner half-lap joints, cut the one shoulder and the depth of the joint with the saw rather than chiseling for depth. Trimming to the line with the chisel will then be all that is necessary.

4. Chisel the joint

Remove the waste stock with a chisel. Work from both sides of the cut, leaving the waste material high

in the center. (Fig. 307.) Finish accurately to the gauge lines by paring, holding the chisel as in Figure 308. The hand next to the stock acts as a guide and also holds the chisel back. The hand on the handle applies the pressure. When possible, the cutting stroke should be at about 45

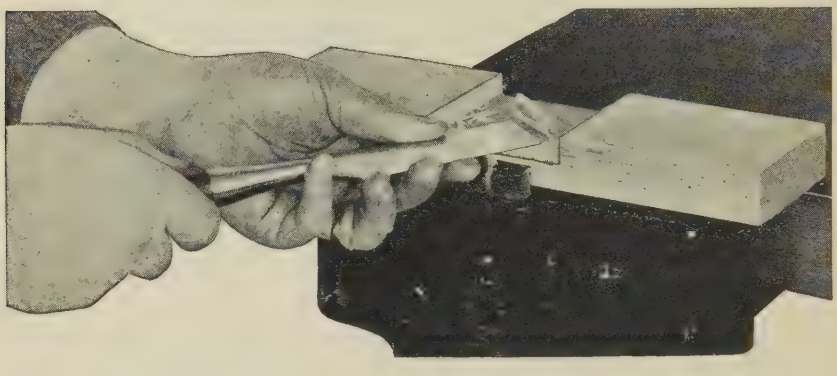


Fig. 308. Paring a half-lap joint with a chisel

degrees to the grain rather than at right angles. Rocking the handle back and forth as the chisel is pushed forward will aid in the cutting. Test the cut for proper depth at all places with a straightedge or the edge of the chisel. (Fig. 307, C.)

5. Assemble the joint

Make a trial assembly to see if the joint fits properly. It should push together with ordinary pressure from the hands. Do not force the pieces together. If the joint is too tight, locate the place where it binds, and pare off a thin shaving. It should be tight enough so that it will not fall apart of its own weight. The face sides of the two pieces should be exactly flush when it is finally assembled.

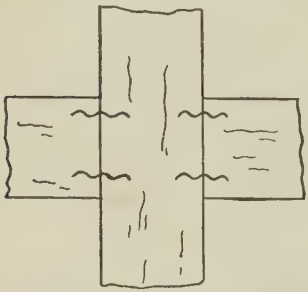


Fig. 309. Half-lap joint fastened with corrugated fasteners

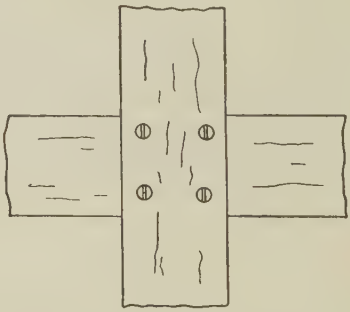


Fig. 310. Half-lap joint fastened with screws

6. Fasten the joint

A variety of methods are used in fastening half-lap joints. The method selected should be appropriate for the particular purpose. In thin stock, nails seldom are used. Short corrugated fasteners (Fig. 309), or screws (Fig. 310), are often used. If set from below or from the back side, they may not be seen. The addition of glue will strengthen the fastening of the joint.

QUESTIONS:

1. What is a half-lap joint?
2. Name several different types.
3. Where are half-lap joints used?
4. How are half-lap joints fastened?
5. What two methods may you use for drawing lines for the width of the joint?
6. What is the advantage in using a screw clamp for holding the pieces when marking?
7. When it is difficult to superimpose one piece on the other for marking, how is the joint laid out?
8. Why do you square the lines on the edge *from* the face side?
9. Why do you gauge for depth from the surfaces that are to be flush when the joint is assembled?
10. Would it make any particular difference if the gauge were not set exactly to one half the thickness of the stock?
11. Why should the gauge lines not extend beyond the joint?
12. How are the shoulders of the joint cut?
13. What is the advantage of several saw kerfs in a wide joint?
14. How would you cut to the depth line in an end-lap joint?
15. Why should you chisel from both sides in chiseling a joint?
16. What is the advantage in rocking the handle of the chisel as you pare?
17. How do you test for the proper uniform depth?
18. How tight should the joint fit before fastening?
19. How would you fasten a lap joint made in thin stock?

UNIT 33

TO MAKE A RABBET-AND-BUTT JOINT

A rabbet is a recess cut out of the end or edge of a board. (Figs. 311 and 312.) The rabbet is usually cut at right angles to the surface, and may be cut either across or with the grain. When a piece is butted into the rabbet, it is called a rabbet-and-butt joint. (Fig. 313.)

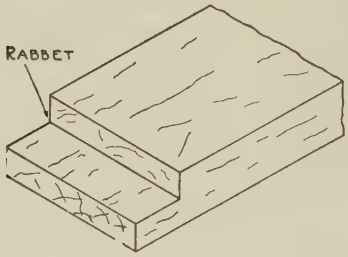


Fig. 311. A rabbet cut across the grain of the stock

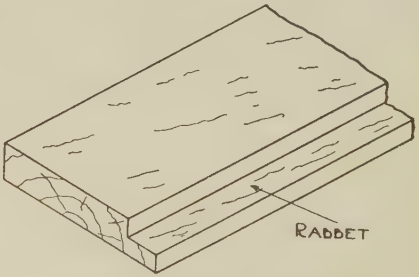


Fig. 312. A rabbet cut with the grain of the stock

The rabbet joint is used extensively in all sorts of woodwork. Drawer fronts are often rabbeted to accommodate the side rails. The corners of chests are sometimes rabbeted to accommodate the side rails, and sometimes for appearance and strength. Some door and window frames are rabbeted. A special rabbeting plane (Fig. 319), or a combination plane (Fig. 320) may be used to cut rabbets across as well as along the grain. A spur is provided on these planes for cutting across the grain. When a rabbeting plane is used, the depth gauge and fence regulate the depth and width of the cut, and a layout is unnecessary.

Short rabbets across the grain are usually cut with a saw, or with a saw and chisel.

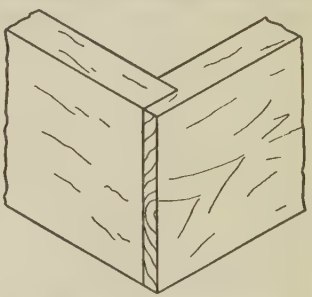


Fig. 313. A rabbet-and-butt joint

Tools: Rule; gauge; try-square; knife; pencil; saw; chisel; special rabbeting plane, or combination plane.

Material: Stock for the joint; nails; glue; screws.

PROCEDURE:

1. Square up the stock

See Unit 9. The pieces to be joined should be uniform in width. Be sure the "joint edges" and the "face sides" can be identified. Carefully square the ends to be joined.

2. Layout for the rabbet

a) Mark the width of the rabbet and square a line across the face. The width of the rabbet should equal the thickness of the stock butted into the rabbet. Superimpose, that is, hold one piece over the other in the position it is to occupy, and mark to get the exact width as in Figure 314, or measure back from the end a distance equal to the thickness of the butted piece. Square a line for the cut across the face at the mark. Continue the line down both edges a distance equal to the depth of the rabbet.

Fig. 314. Marking the exact width of a rabbet

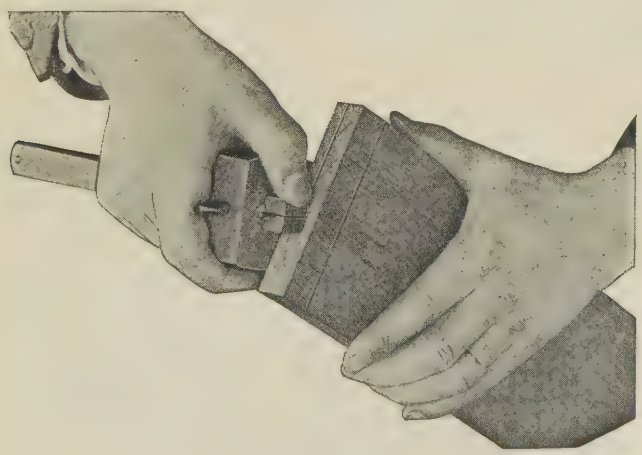


Fig. 315. Gauging for the depth of a rabbet

b) Gauge for the depth of the rabbet. Set the gauge for the depth of the rabbet, and gauge a line along the end and down both edges to the other marks on the edges. The depth of the rabbet should be from one half to two thirds the thickness of the stock. Another method fre-

quently used is to set the gauge for the thickness of the tongue on the rabbeted piece and gauge from the opposite face. (Fig. 315.)

3. Cut out the rabbet

Cut for the depth first. Clamp the piece in the vise, and with a panel or backsaw, cut down to the lines. (Fig. 316.) Begin the cut on the near corner and, as the cutting proceeds, finally bring the saw level.

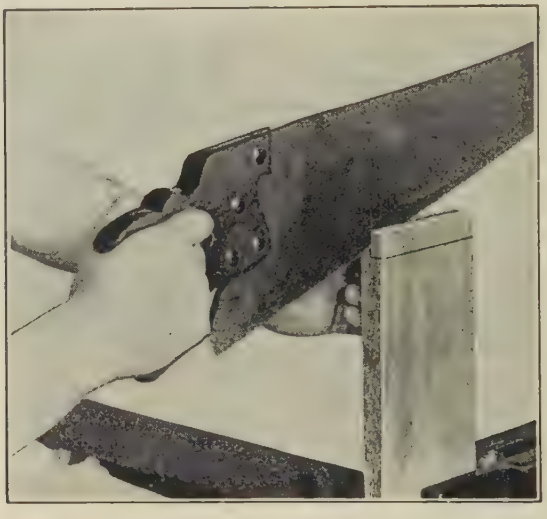


Fig. 316. Ripping for a rabbet

Crosscut the shoulder next. Place the piece flat in the vise or on a bench hook, and cut the shoulder with a crosscut or backsaw. Start the cut on the far arris and finally bring the saw level. A straight piece

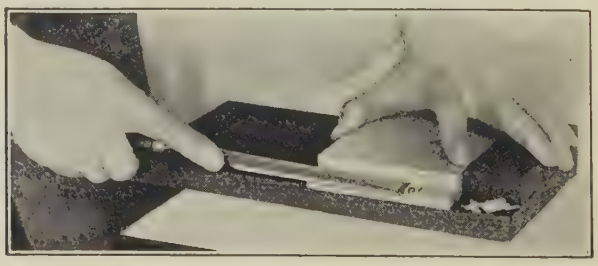


Fig. 317. A skilled workman trimming to the line on a rabbet with a chisel. It will be better for the beginner to clamp the stock and use both hands on the chisel, until skill is acquired. This also will tend to prevent accidents

of scrap stock, clamped or tacked in position, will aid in sawing to the line across a wide surface. (Fig. 324.) Some prefer to saw the shoulder to depth and remove the waste stock with a chisel. In either case, a chisel should be used to fit a joint that has been poorly sawed.

4. Assemble the joint

Make a trial assembly to see if the joint fits properly. Use a chisel and trim the joint until a good fit is secured. (Fig. 317.) Use extreme care in chiseling with one hand, because a slip may mean a cut. If stock can be clamped in the vise, it is best for the beginner to use both hands on the chisel. If the stock cannot be clamped in the vise, it may be clamped to the bench with a hand screw, thus making it possible to use both hands in guiding the chisel.

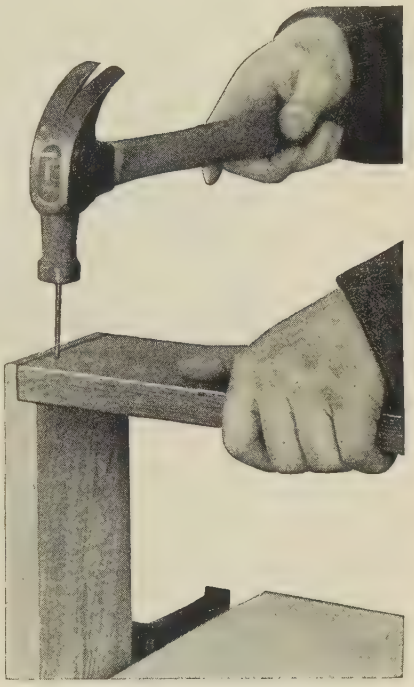


Fig. 318. Nailing a rabbet-and-butt joint

5. Fasten the joint

Finishing nails and glue usually are used to fasten the rabbet-and-butt joint. The butted piece usually is nailed to the rabbeted piece. (Fig. 318.) Sight in the direction of the line of nails. Start the nail as far back from the butt end as possible to prevent splitting. In attempting to drive a nail slanting, take care that it does not come out on the face of the stock. Set the nails for a finish job. Screws may be used to fasten the joint. Use long slender screws when they go into end grain. (See Unit 28.)

QUESTIONS:

1. What is a rabbet?
2. At what angle to the surface is a rabbet usually cut?
3. What is a rabbet-and-butt joint?
4. Where is the rabbet joint used?
5. Are rabbets cut with, as well as across, the grain?
6. What special planes may be used for rabbeting?
7. Why is it unnecessary to make a layout for a rabbet when a special plane is used?

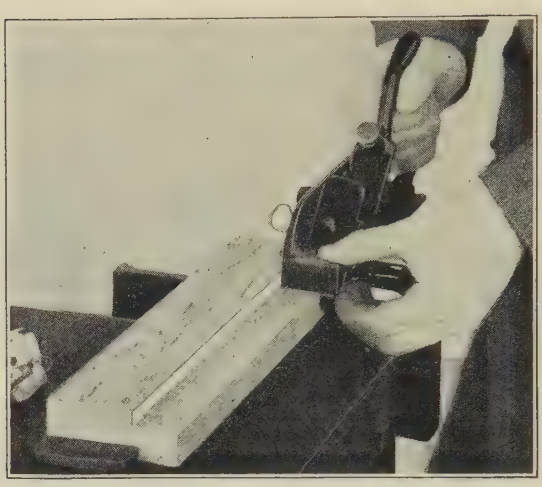


Fig. 319. Cutting a rabbet with a rabbeting plane

8. How are short rabbets across the grain usually cut?
9. Why should the ends be squared accurately for a rabbet joint?
10. How do you mark for the exact width of the rabbet?
11. What two methods are used in gauging for the depth of the rabbet?
12. What is the advantage in placing the piece low in the vise when ripping for a rabbet?
13. What is the advantage in sawing accurately to the line for a rabbet?
14. What tool is used for trimming a rabbet joint?
15. How are rabbeted joints fastened?
16. In which piece do you start the nails or screws? Why?
17. What kind of screws should be used for fastening a rabbet joint?

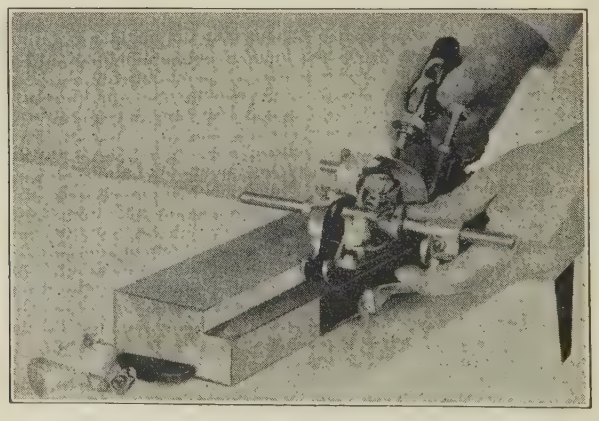


Fig. 320. Cutting a rabbet with a combination plane. This plane also can be used for cutting grooves, moldings, etc.

18. Why would you start the nails or screws as far back from the butt ends as possible?

SUGGESTED PROBLEMS:

1. Use a rabbeting plane to cut a rabbet. (Fig. 319.)
2. Use a combination plane to cut a rabbet. (Fig. 320.)

The combination plane illustrated will also cut grooves, dadoes, chamfers, hollows, rounds, and make moldings of various designs. This is accomplished by different cutters furnished with the plane. The manufacturer of the plane furnishes well-illustrated pamphlets on how to adjust and use it. Such a tool is a valuable asset to any woodworking shop.

UNIT 34

TO MAKE A DADO-AND-BUTT JOINT

A plain dado is a groove cut across the grain of a piece of stock and extending throughout its entire width. (Fig. 321.) A similar opening cut in the direction of the grain of the wood is called a "groove."

When another member is inserted in the dado, it is called a "dado joint." If the entire end of a piece is inserted, it forms a dado-and-butt, or housed dado joint. (Fig. 322.) A dado which does not extend the

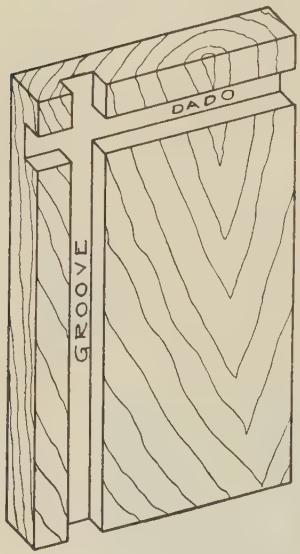


Fig. 321. A dado is cut across the grain. A groove is cut with the grain

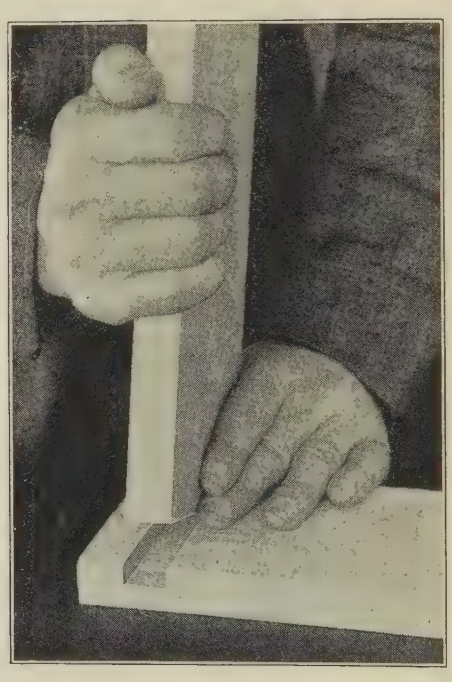


Fig. 322. Assembling a dado-and-butt joint

entire width of the piece is called a "stopped dado" or "gain." Directions for gaining are given in Unit 36.

Dado joints are used extensively. They are comparatively easy to make and are stronger than butt joints. The legs of a step ladder are often dadoed for the steps, to insure stronger joints. The backs of

drawers fit into dadoes in the side rails. Dadoes are made in the ends of bookcases to support the shelves. A carpenter uses the dado joint to advantage in many places.

Tools: Try-square; knife or pencil; gauge; back or panel saw; chisel, or router plane.

Material: Stock for joints; nails; screws; glue.

PROCEDURE:

1. Square up the pieces (Unit 9)

Time will be saved in the making, and a better joint should result if the pieces are squared up accurately.

2. Lay out the dado

a) *Locate the position of the dado.* Measure on the desired face to locate one side of the joint. Square a line across the surface at this point for one side of the cut

b) *Mark the line for the width of the dado.* Hold the piece that fits into the dado, in its proper place. Hold securely as you mark along the piece for the width of the cut. (Fig. 323.) Mark the pieces so they may be replaced in the exact position.

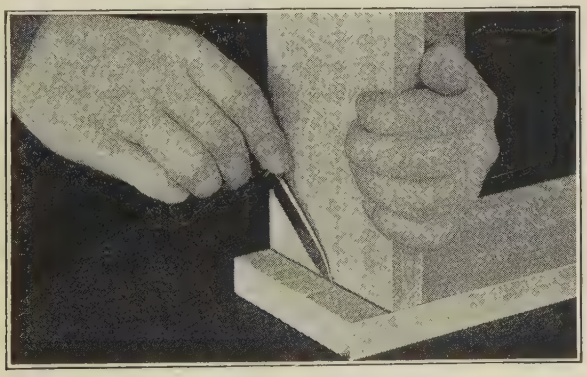


Fig. 323. Marking for the width of a dado

c) *Square lines down both edges equal to the depth of the dado.*

d) *Gauge for the depth of the dado.* Set the gauge for the depth of the dado, and gauge between the lines on both edges. Use care not to gauge beyond the lines as the gauge marks will show in the construction.

3. Saw the shoulders of the dado

A straight piece of scrap stock, clamped or tacked in position, will aid in sawing to the line across a wide surface. (Fig. 324.) Use a backsaw or a fine panel saw. Have the saw kerfs entirely in the waste

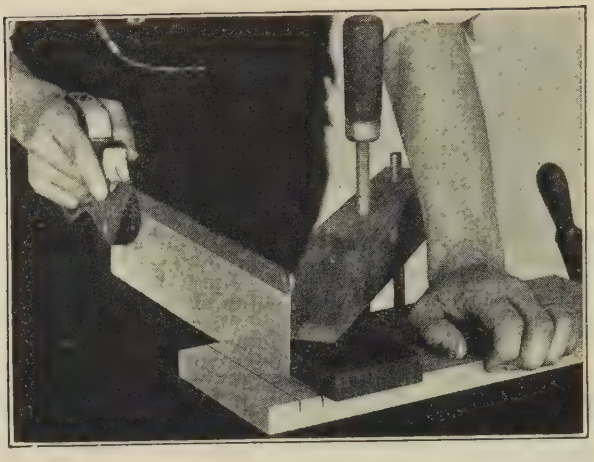


Fig. 324. Sawing a shoulder of a dado with a guide clamped in position

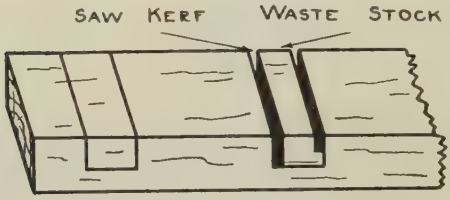


Fig. 325. Saw in the waste stock when making a dado

stock. (Fig. 325.) This will insure a snug fit. Use care, and saw just down to the gauge lines.

4. Chisel out the dado

Chisel from one edge to the middle. Reverse the piece, and work from the other edge. (Fig. 326.) A hardwood block (Fig. 327) with an

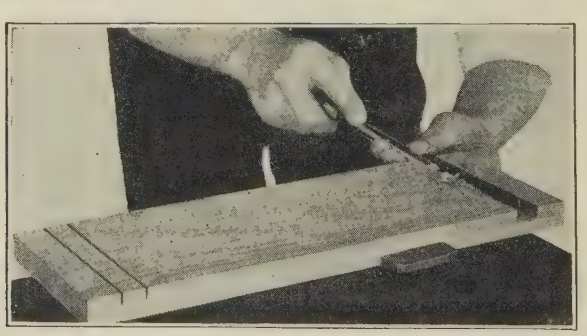


Fig. 326. Chiseling a dado

adjustable screw, will make a good depth gauge. This gauge is useful for testing uniform depth of dadoes. Finally test with a straightedge from one gauge line to the other to see that the joint is true. See Unit 32, step 4, for additional directions on chiseling.

Figure 328 shows the method of removing the stock from a dado with a router plane. The router plane is especially convenient when a number of dadoes of the same depth are to be cut.

Fig. 327. A hardwood block with an adjustable screw makes a good depth gauge for testing dadoes

5. Make a trial assembly

Make a trial assembly to see if a good fit has been secured. It is often necessary to remove a little stock to get a good fit. Use a chisel to trim the dado, and a plane for trimming the piece butted into the dado. It is difficult to accurately trim the shoulders of the dado with a chisel, but the thickness of the butted piece can easily be reduced by planing.

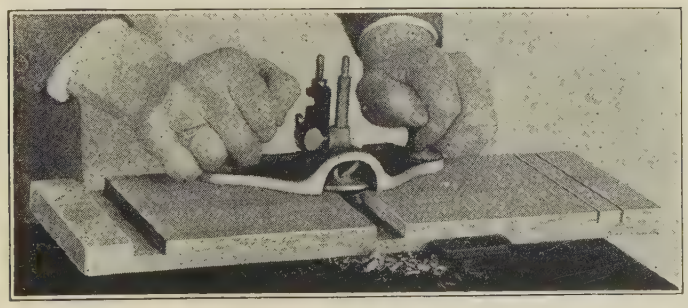


Fig. 328. Using a router plane to remove the waste stock from a dado

6. Fasten the joint

Glue may be used where appearance is essential and when the use of screws or nails would be objectionable. Glue used in connection with either screws or nails will strengthen the joint.

Screws will give a stronger joint than nails. They should be long and slender, since they usually enter end grain. See Unit 28 for directions for setting screws.

Nails may be used where there is little tendency for the butted pieces to be pulled straight out of the dado. Drive the nails at an angle to secure the greatest strength. Figure 329 shows a method of nailing a dado-and-butt joint.

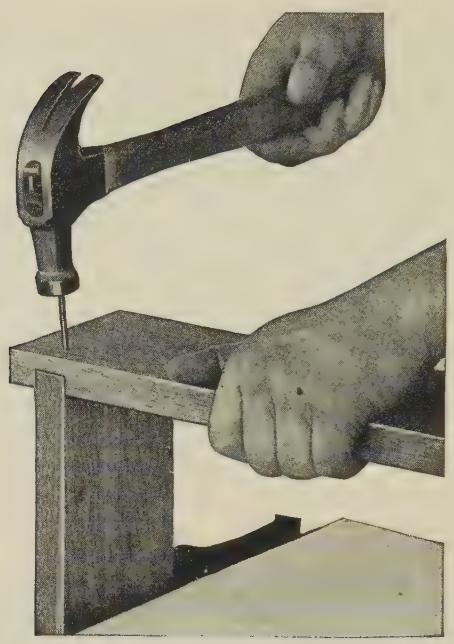


Fig. 329. Method of nailing a dado-and-butt joint

QUESTIONS:

1. What is a dado?
2. What is a groove?
3. What is a dado joint?
4. What is a housed dado joint?
5. What is a "stopped dado" or a "gain"?
6. Where are dado joints used?
7. What is the advantage of a dado joint?
8. Why use the piece as a guide to mark for the width of a dado?
9. How deep is the dado in Figure 8?
10. How is the depth of a dado laid out?
11. How are the shoulders of a dado cut?
12. Why chisel from both sides of a dado?
13. How may a depth gauge for testing a dado be made?
14. What is a router plane?
15. When would you use a router plane?
16. How are dado joints fastened?
17. How are the dado joints to be fastened in Figure 8?

UNIT 35

TO MAKE A RABBET-AND-DADO JOINT

A rabbet-and-dado joint is made by inserting the tongue of a rabbeted piece into a dado. (Fig. 330.) The joint is made in a manner similar to the dado-and-butt joint. The rabbet is first laid out and cut, and then the procedure necessary to complete the joint is practically identical with that of the dado-and-butt joint.

The rabbet-and-dado joint (Fig. 331) is principally used for corner construction and gives additional strength. The joint is often used at the corners of boxes and chests. Drawer fronts and backs are sometimes joined with the side rails as in Figure 333.

Tools: Try-square; knife or pencil; gauge; panel or backsaw; chisel; mallet; hammer; nail set; drills; screw driver.

Material: Stock for the joint; nails; glue; or screws.

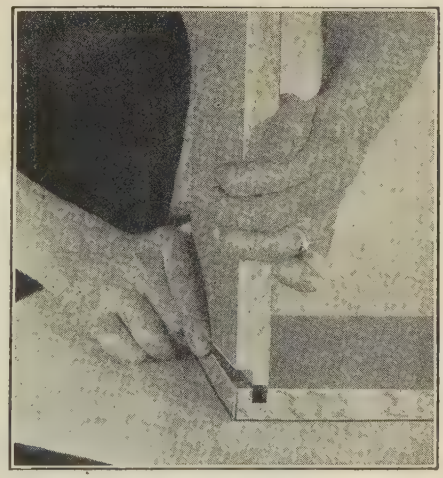


Fig. 330. Assembling a rabbet-and-dado joint

PROCEDURE:

1. Square up the pieces
(See Unit 9)

Do this accurately to save time and also to secure a better joint.

2. Mark the location of the dado

Place the pieces in the position they will occupy in the joint. Place them flush on the outside, as shown in Figure 314. Use a sharp pencil or preferably a knife, and place a mark on the inside. This mark locates the inside of the dado. Square a line across the piece at this mark. It is possible to lay out the entire joint by measurement if that method is desired.

3. Lay out the rabbet

a) Square a line for the length of the tongue. The length of the tongue is equal to the depth of the dado. Measure this distance back from the end, and square a knife line across the face. Continue this line part way across each edge.

b) Gauge for the thickness of the tongue. (Fig. 315.) The thickness of the tongue is usually about one half the thickness of the stock, or slightly less. Gauge across the end and down both edges to the other marks. Hold the block of the gauge on the face opposite the one on which the rabbet is cut.

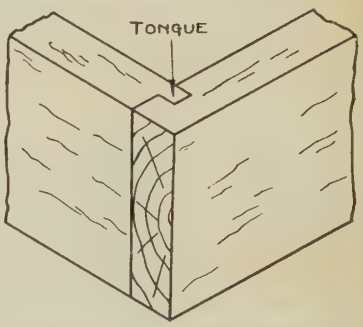


Fig. 331. A rabbet-and-dado joint

4. Cut out the rabbet

See Unit 33, step 3.

5. Lay out the dado

a) Mark for the width of the dado. Place the pieces again in position, and mark as in Figure 332. This will give a dado of exact width to correspond with the thickness of the tongue on the rabbeted piece. Square a line across the piece for the width of the cut. Extend both lines down both edges a distance equal to the depth of the dado.

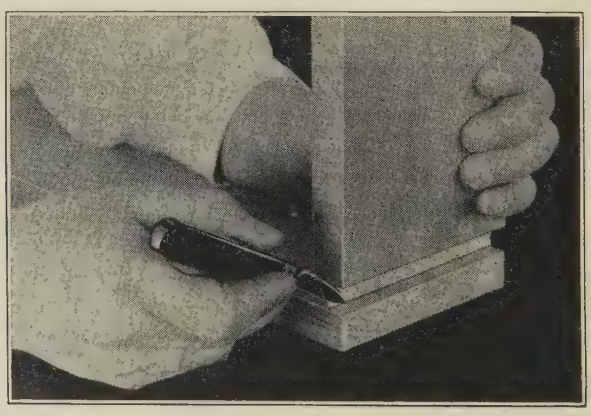


Fig. 332. Method of marking for the width of a dado for a rabbet-and-dado joint

b) Gauge for the depth of the dado. This distance should equal the length of the tongue on the rabbeted piece. Set the gauge accurately and gauge between the lines on both edges.

6. Cut out the dado and fit the joint

(See Unit 34, Steps 4 and 5)

7. Fasten the joint

Nails and glue are ordinarily used to fasten such a joint. Use finishing nails or brads on thin stock. The nails are usually driven through the dado into the tongue of the rabbet. Be careful not to split off the shoulder of the dado. Slanting the nails will give a stronger joint where there is a tendency for the rabbeted piece to be pulled out of the dado. Figure 333 shows a method of nailing rabbet-and-dado joints commonly used in drawer construction.

When nailing near the end of a piece, it is advisable to drill holes for the nails. It would be better to drill through the side rail in nailing the double rabbet-and-dado joint in Figure 333. This is especially necessary when hard wood is used.

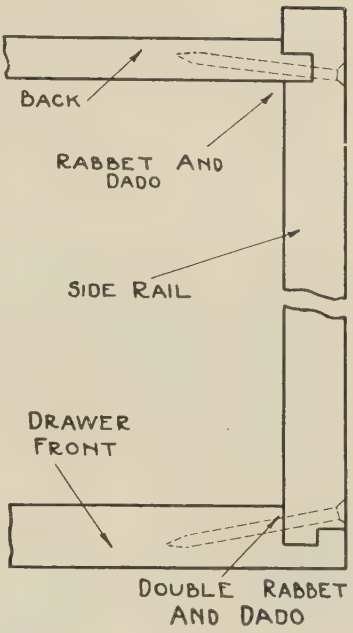


Fig. 333. Method of nailing rabbet-and-dado joints which are often used in drawer construction

If screws are used for the joint, they should be quite long since they are set into end grain.

QUESTIONS:

1. What is a rabbet-and-dado joint?
2. Where is a rabbet-and-dado joint used?
3. What is the advantage of this joint?
4. What is the tongue of a rabbet?
5. How can rabbets be cut?
6. Why use the method of superposition in laying out joints?
7. Can all joints be laid out by measurement?
8. What is the advantage of a knife line for laying out?
9. What is the usual thickness of the tongue of a rabbet?
10. Give steps for chiseling out a dado. (See Unit 34, step 4.)

UNIT 36

TO GAIN FOR A JOINT

A gain is a groove which does not extend the full width or length of the surface. (Fig. 334.) Gains are usually made on the face and edge, but occasionally they are made on the end of a piece. When the gain is cut across the grain, it is sometimes called a stop dado.

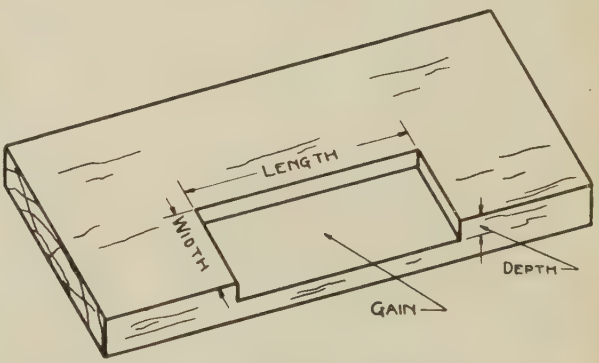


Fig. 334. Illustrating a gain and method of dimensioning

Gains are sometimes made to fit another piece of stock, such as the ends of drawer slides, braces, and the like. However, the principal use of the gain is in the installation of hardware. Butt hinges, gained locks, lock strikes, etc., must be set flush with the surface, and gaining is necessary.

Accuracy is essential in laying out and cutting a gain since so much often depends upon it. If a door is to close properly, the hinges must be set accurately, and if a lock is to function, it must also be set properly. Gains are cut mainly with a chisel.

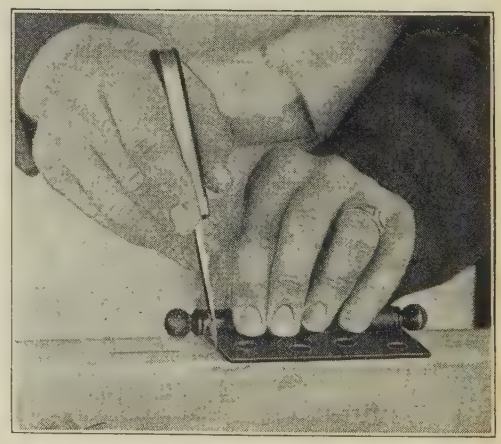


Fig. 335. Marking the length of a gain for a hinge

The chisel is a handy tool in the shop and around the house, and because of its common use, it is well to develop skill in using it.

Tools: Rule; try-square; knife; pencil; gauge; chisel; mallet.

Material: Stock to be gained; hardware to be attached or piece to be inserted.

PROCEDURE:

1. Lay off the length of the gain

To lay off the length of a gain by measurement, use a rule and a try-square. Hinges (Fig. 335), locks, and pieces of stock (Fig. 336) can be held in place, and the length accurately marked with a knife or sharp pencil. Continue these lines down the adjacent surface, a distance equal to the approximate depth of the gain. (These lines may be omitted for shallow gains.)

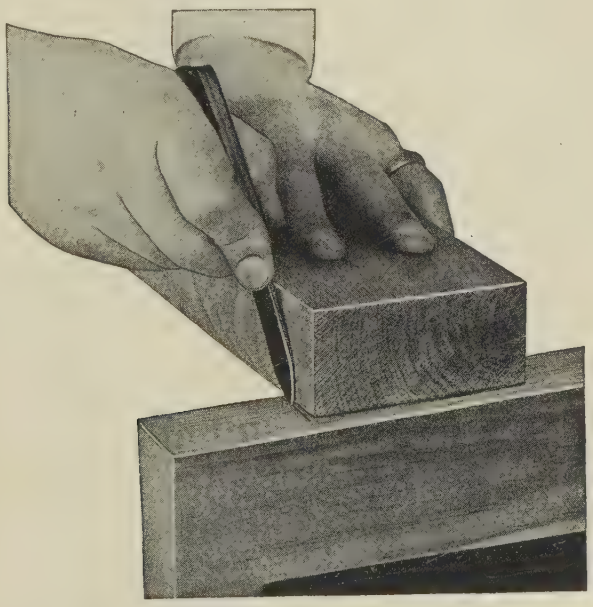


Fig. 336. A piece of stock held in position to mark the length of a gain

2. Lay off the width of the gain

The gauge usually is used for this operation. Set the gauge at the width, and gauge between the lines laid out for the length. (Fig. 337.)

3. Lay off the depth of the gain

Set the gauge for the proper depth, and gauge between the lines laid out for the length. Gauge on one surface only, as a gain does not extend the full width or thickness of the piece. The gain should sometimes be slightly deeper than the thickness of the piece to be inserted in it. This is often true in gaining for hinges and lock strikes.

4. Score the gain

The gain can be roughed out by scoring. (Fig. 338.) Scoring is accomplished by striking the chisel with a mallet. (Fig. 339.) Score uniformly so that chips will be easily removed. The depth of the scores should be slightly less than the depth of the gain. At the ends of the gain, hold the chisel perpendicular, with the flat side of the chisel toward the end of the gain. This will give a square shoulder at the ends. Between the ends of the gain hold the chisel with the bevel down and at an angle of 55 or 60 degrees.

Fig. 337. Gauging for the width of a gain

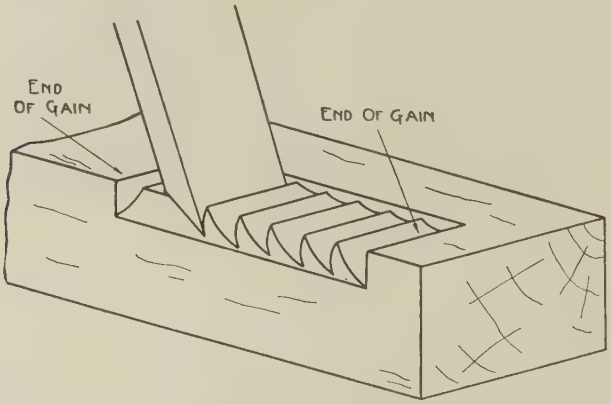


Fig. 338. Rough out a gain by scoring. Score the ends of the gain first and then rough out the gain with the chisel held at an angle of 55 or 60 degrees

5. Pare the gain

Pare from the side of the gain. (Fig. 340.) If the gain is wide, hold the chisel, for most of the cutting, at about 45 degrees rather than at right angles. (Fig. 308.) It is always necessary, however, to pare at right angles in the corner of a gain. Use one hand as a guide and depth gauge, by bracing it against the stock and holding firmly to the chisel. Apply pressure at the handle of the chisel with the other hand. Rock the chisel b a c k and f o r t h horizontally as it is pushed forward. This gives a paring or shearing cut. Pare down to the gauge line. The bottom of the gain should be true and smooth.

Fig. 339. Scoring a gain with a chisel and mallet

6. Test the gain

Insert the stock or hardware in the gain to test for fit. Remove any imperfection with a chisel. If the gain has been made too deep, use a shaving or piece of c a r d b o a r d under the stock or hardware. Such a thin piece is called a shim

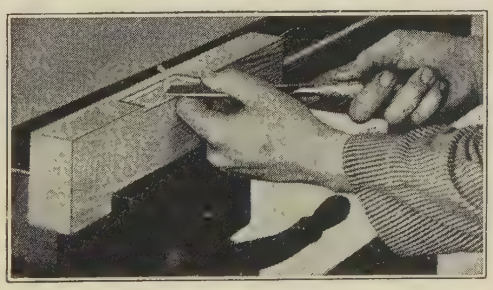


Fig. 340. Paring a gain

QUESTIONS:

1. What is a gain?
2. Gains are usually made on what surfaces?
3. What are the purposes of a gain?
4. What is the principal use of a gain?
5. Why is accuracy essential in laying out and cutting a gain?
6. What tool is used for cutting out a gain?

7. Why should skill be developed in the use of a chisel?
8. How would you lay out the length of a gain for a hinge?
9. How is the width of a gain usually laid out?
10. What usually determines the depth of a gain?
11. What is scoring?
12. What is the advantage in scoring when cutting out a gain?
13. How is the chisel held when cutting at the ends of a gain?
14. How deep should the score be?
15. What is the advantage in holding the chisel at an angle when paring?
16. How is the cut of the chisel regulated when paring?
17. What is the advantage in rocking the handle of the chisel when paring?
18. How is the gain tested?
19. If a gain has been made too deep, what is a remedy?

UNIT 37

TO MAKE A MORTISE-AND-TENON JOINT

A mortise-and-tenon joint is one in which the rectangular end (the tenon) of one piece fits into a rectangular hole (the mortise) of the same size, in the other piece. Mortise-and-tenon joints are made in a number of different types. The *blind* mortise-and-tenon (Fig. 341) is the most common. It is used extensively in cabinetmaking for joining rails to legs or stiles, and in many other constructions as well. The *through* mortise-and-tenon (Fig. 352) is similar to the blind, except that it extends all the way through the piece. It is often used in frames where the edges are hidden. The *open* joint (Fig. 354) is similar to the through mortise-and-tenon, and is sometimes used on the corners of frames. The *haunched* mortise-and-tenon (Fig.355) is used where a project is paneled, or where a rail is at the end of a leg as in a table. Where the rails, stiles, or legs have grooves to hold the panels, a short tongue is left on the tenon to fill the groove. This is necessary on paneled doors, paneled ends of cabinets, etc.

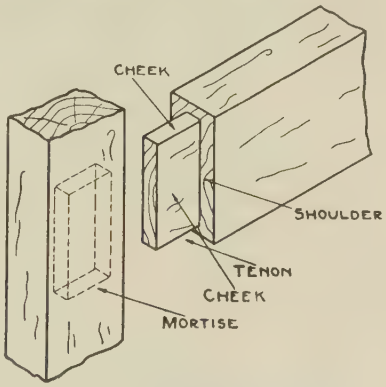


Fig. 341. A blind mortise-and-tenon joint with four shoulders. The number of shoulders may vary from one to four

When properly designed, proportioned, and well made, mortise-and-tenon joints are strong and neat in appearance. As a general rule, in the design, the proportions should be such that the tenon will be equal in strength to the stock remaining in the mortised piece. To secure a snug fit, the joint must be laid out accurately, and the workman must work carefully to the lines. The same general plan is followed in making the different types. Various methods are used for fastening the joint, some of which are shown in Figures 350, 351, and 353.

Materials: Stock for the joint; fasteners.

Tools: Rule; try-square; knife; saw; marking gauge; chisels; brace and bits; adjustable depth gauge.

PROCEDURE A: To Make a Blind Mortise-and-Tenon Joint

1. Square up the stock

In the construction of a project, be sure to allow for the length of the tenons on the pieces. Square the stock accurately to dimensions; otherwise, you will have difficulty in assembling.

2. Lay out the mortise

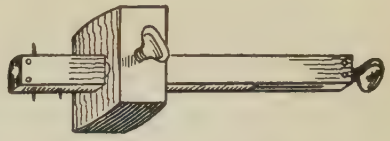


Fig. 342. Mortising gauge

Note the dimensions of the mortise in the drawing, and also the exact location of it. Lay out points with a rule for the length of the mortise, as in Figure 22. Square lines across the surface at these points with the try-square. Set the gauge accurately and gauge lines for the width, from the face side. A mortise gauge (Fig. 342) may be used to gauge both lines for the width at the same time. If you are to make a number of joints of the same dimensions, do the same operations on all pieces at the same time. Check to see that the length of the mortise corresponds with the width of the tenon, and also the width of the mortise with the thickness of the tenon. (Fig. 343.)

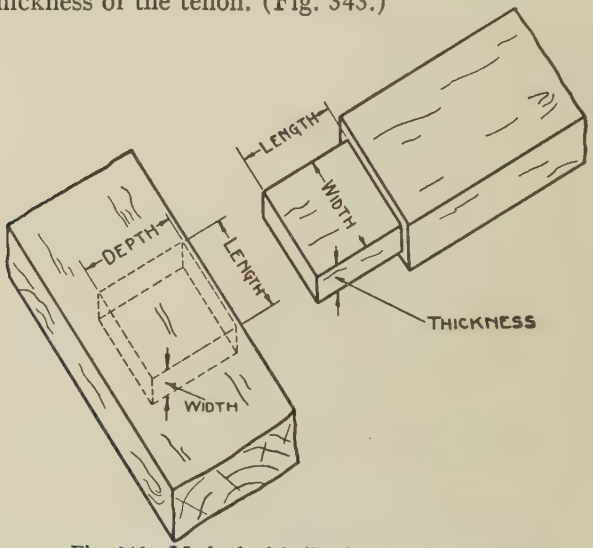


Fig. 343. Method of indicating the dimensions of a mortise and tenon

3. Remove the stock from the mortise with brace and bit

(This step may be omitted if you use a mortising chisel.)

Select a bit 1/16 in. smaller than the width of the mortise. Place an adjustable depth gauge on the bit, to regulate the depth of the hole.

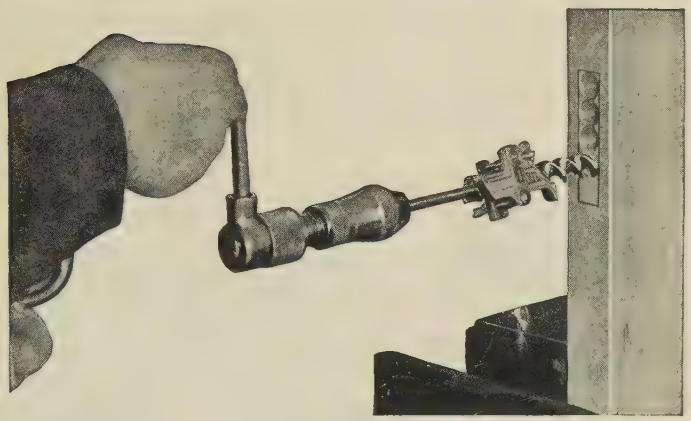


Fig. 344. Removing the waste stock from a mortise by boring

The mortise should be slightly deeper than the length of the tenon. Bore a series of overlapping holes as in Figure 344. Remove as much stock as possible in this manner.

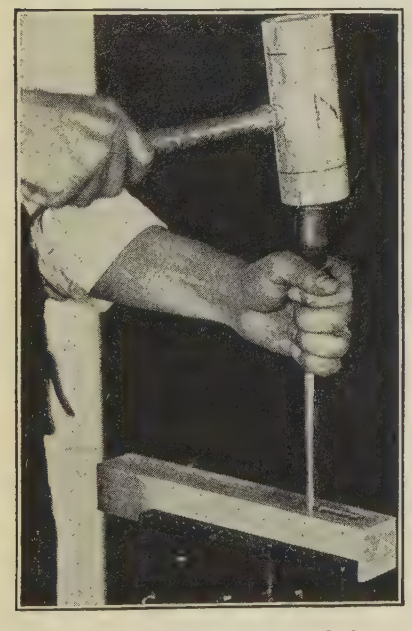


Fig. 345. Chiseling waste stock from a mortise

4. Chisel the mortise

Use a chisel, as in Figure 345, to remove the bulk of the waste stock. Make sure that you do not remove

Fig. 346. Paring a mortise

the lines. Hold the chisel perpendicularly when working near the ends or sides. Pare to the lines with the chisel as in Figure 346. Do not make the mortise too big.

A mortising chisel (Fig. 347) is made especially for the purpose of chiseling a mortise, and may be used when available. It is not necessary to remove the waste stock by boring when a mortising chisel is used. Select one which is the size of the width of the mortise. Hold the mortis-

Fig. 347. Cutting a mortise with a mortising chisel

ing chisel inclined as in Figure 347, and use a mallet to remove the stock from the center of the mortise. Work from the center toward each end, holding the back of the chisel toward the end. As you approach the end, hold the chisel perpendicularly. This will give square shoulders to the mortise. Pare carefully at the ends, using both hands on the chisel, instead of pounding with the mallet.

5. Lay out the tenon

Refer to the drawing for the dimensions. Note the length, and square a line around the rail. Note the dimensions of the shoulder on the face side. Set the gauge accurately, and gauge from the face side. Add to this dimension the thickness of the tenon, and gauge from the face side

again. This gives a tenon uniform in thickness, and parallel with the face side. Test to see that the tenon is of the correct thickness. To lay out the width of the tenon, proceed as above, gauging from the joint edge. Never gauge past the shoulder line, as this may show in the construction.

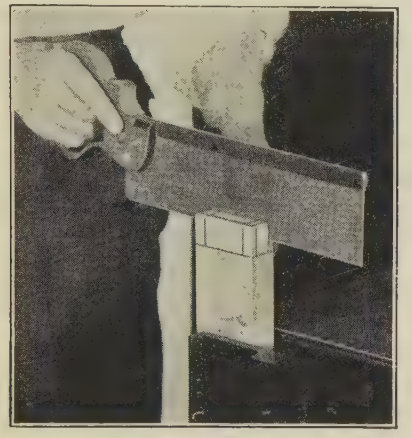


Fig. 348. Sawing a tenon

Fig. 349. Saw to the line in cutting a tenon. The saw kerf should be in the waste stock.

6. Cut the tenon

Use the backsaw as in Figure 348. In heavier stock, a panel or ripsaw may be used to advantage. Saw carefully to the line in the waste stock. (Fig. 349.) By ripping first, the pieces on which the gauge lines are scribed will remain in place until you have finished sawing. Do not rip past the shoulder line. Crosscut accurately around the stock to the shoulder line. Do not make the tenon too small.

7. Fit the joint

Attempt to insert the tenon in the mortise. You should have a snug fit. If necessary, use a chisel and remove the stock from either the mortise or the tenon to secure the fit. Do not use too much force. The tenon should go in with pressure applied by the hand. When fitted, number the tenon and mortise to correspond.

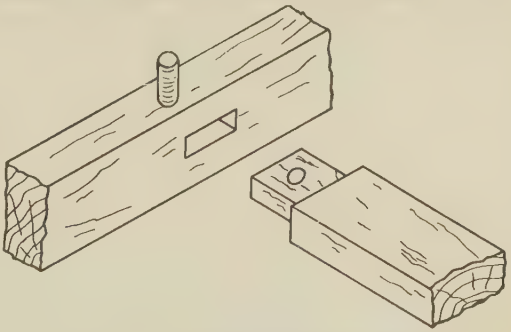


Fig. 350. A wooden dowel used to fasten a mortise-and-tenon joint

8. Fasten the joint

Glue is commonly used in cabinet construction. Where additional strength is desired, use other fasteners. Wooden dowels (Fig. 350) give a secure method of fastening. Where they are used, draw-bore the hole. First, bore a hole in the mortised piece. Then insert the tenon in the mortise, and locate the center of the hole on the tenon. Bore the hole in the tenon slightly closer to the shoulder, so that, when the joint is assembled and the dowel or pin driven into the offset hole, the shoulders are drawn up tightly. Metal dowels (Fig. 351) are often used in frame construction. The frame is securely clamped and the dowels driven and set with the hammer and nail set. Holes should be drilled in hard woods before driving the metal dowels. Bolts or screws are sometimes used where strength and not appearance is essential.

Fig. 351. Barbed metal dowels are sometimes used to fasten mortise-and-tenon joints

PROCEDURE B: To Make Other Mortise-and-Tenon Joints

a) ***Through Mortise-and-Tenon Joint*** **(Fig. 352)**

Lay out the mortise for this joint on both sides of the mortised piece,

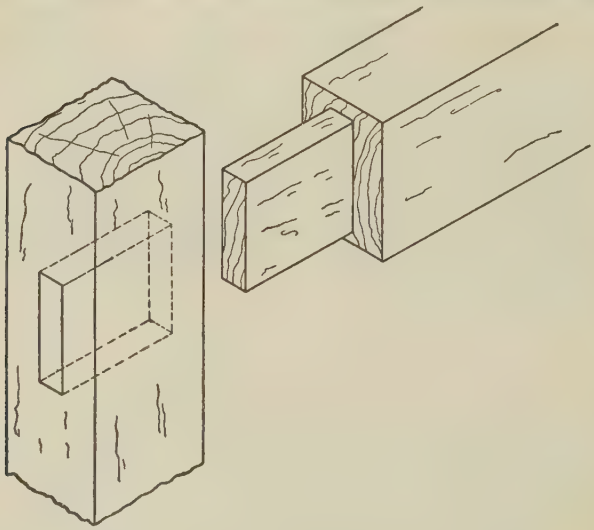


Fig. 352. A through mortise-and-tenon joint

and bore or chisel from each side. Cut the tenon equal in length to the depth of the mortise. Fasten as above, or use wedges as in Figure 353. In case wedges are used, the mortise is given a flare. Saw kerfs are cut in the tenon, and glue is applied to the wedges before they are driven in place.

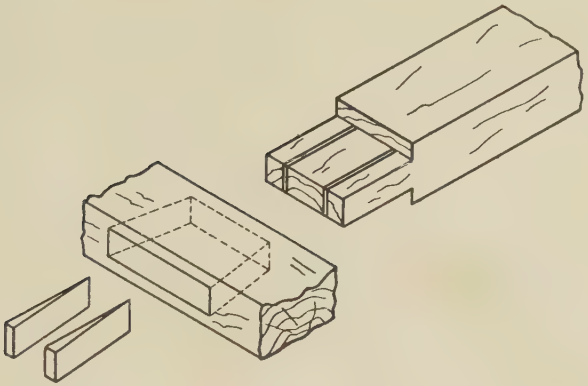


Fig. 353. Wedges are sometimes used to fasten a through mortise-and-tenon joint

b) ***Open Mortise-and-Tenon Joint*** (Fig. 354)

The open mortise-and-tenon joint is very similar to the through mortise-and-tenon, except that the mortise is cut at the end of the piece. This joint is used successfully on the corners of frames. The mortise should be laid out on both sides, and the lines extended around the end. Saw out as you would the cheeks of a tenon, and bore a hole at the inner end of the mortise to remove the waste stock. Chisel out the end to remove the round shoulder left by the auger bit. Use any of the above methods, except wedging, for fastening the joint.

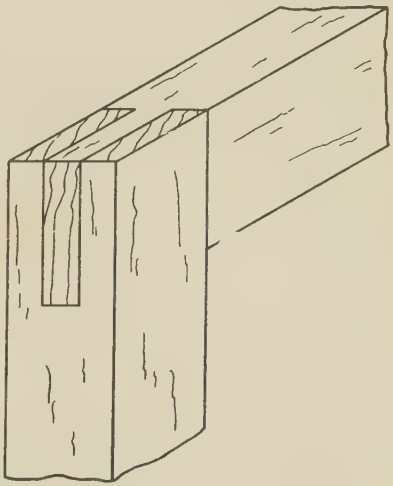


Fig. 354. An open mortise-and-tenon joint

c) ***Haunched Mortise-and-Tenon Joint*** (Fig. 355)

A haunched mortise-and-tenon joint is desirable where a rail joins a leg or stile as in panel construction. This reduces the length of the mortise at the end of the leg or stile, thus making a stronger joint. A haunched mortise-and-tenon joint is necessary where a groove for a panel must be cut on the edge of the mortised piece in line with the mortise. The haunch is a projection left on the tenon to fill up the groove beyond the end of the panel. In the usual joint of this type, the width of the mortise is equal to the width of the groove. The

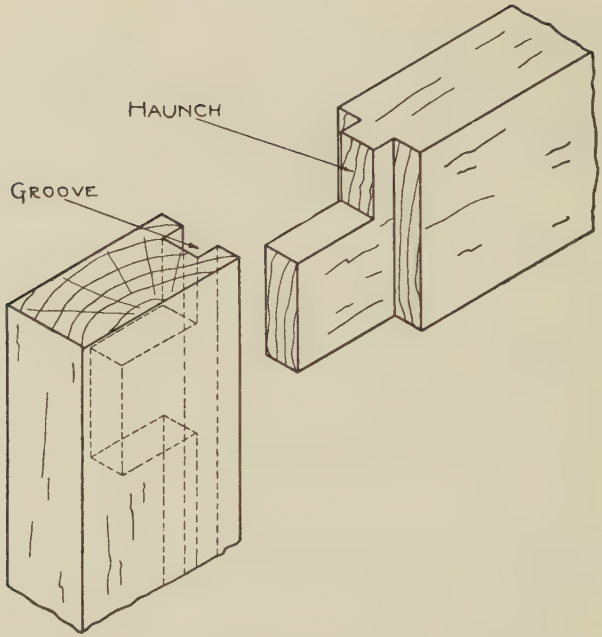


Fig. 355. A haunched mortise-and-tenon joint

mortise should be located in line with the groove. Cut the mortise in the usual manner, but when sawing the tenon, be sure to leave the haunch which is necessary to fill up the groove. This joint is usually glued, since it is used mainly in cabinet construction.

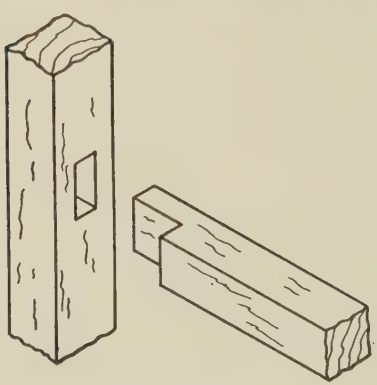


Fig. 356. A barefaced mortise-and-tenon joint

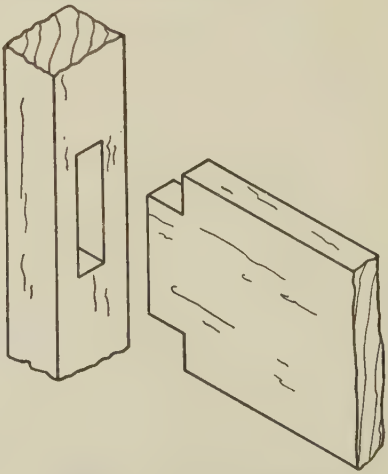


Fig. 357. A stub mortise-and-tenon joint

d) Other Mortise-and-Tenon Joints

Figure 356 shows a barefaced mortise-and-tenon joint. A stub joint is shown in Figure 357. NOTE: The number of shoulders on a tenon is optional and varies from one to four, according to the construction.

QUESTIONS:

1. What is a mortise?
2. What is a tenon?
3. Name the different types of mortise-and-tenon joints.
4. What is the advantage of a mortise-and-tenon joint?
5. Where is the mortise-and-tenon joint used?
6. What should be the proportion in the sizes of the mortise-and-tenon?
7. Which type of mortise-and-tenon joint is used the most? Why?
8. How may the rough stock be easily removed from a mortise before chiseling?
9. How is a mortise cut with a mortising chisel?
10. Do you rip or crosscut first in sawing out a tenon?
11. What is (*a*) the shoulder of a tenon; (*b*) the cheek?
12. When does a tenon fit properly?
13. Why should a tenon be oversize rather than undersize?
14. What fasteners are used in fastening a mortise-and-tenon joint?
15. What is meant by draw-boring?
16. When are bolts used for fastening a mortise-and-tenon joint?
17. How is a through mortise-and-tenon joint sometimes fastened?
18. How is an open mortise cut?
19. Where are haunched mortise-and-tenon joints used?
20. What is the purpose of the "haunch" on a tenon?
21. How many shoulders are there on (*a*) a barefaced tenon; (*b*) a stub tenon? (Figs. 356 and 357.)

UNIT 38

TO HANG A DOOR

Doors should be fitted accurately and hung properly so that they will work easily. Doors and covers usually require hinges. The hinges most commonly used are known as "butts." In the tight-pin butt, the pin is riveted in place. The loose-pin butt allows the pin to be removed. Upright doors are usually hung with loose-pin butts. Tight-pin butt hinges or chest hinges are used on various boxes, tool chests, radio cabinets, and the like. (See Figs. 361, 362, and 363.) The size of a butt hinge is the over-all dimensions in inches with the leaves open. A 2 by 2 butt is one that is 2 by 2 in. when the leaves are open.

Tools: Plane; square; straightedge; saw; rule; knife or pencil; gauge; chisel; mallet; awl or hand drill; screw driver.

Material: Door and frame; hinges and screws.

PROCEDURE:

1. Saw off the stiles

In making a door, the stiles are usually allowed to project beyond

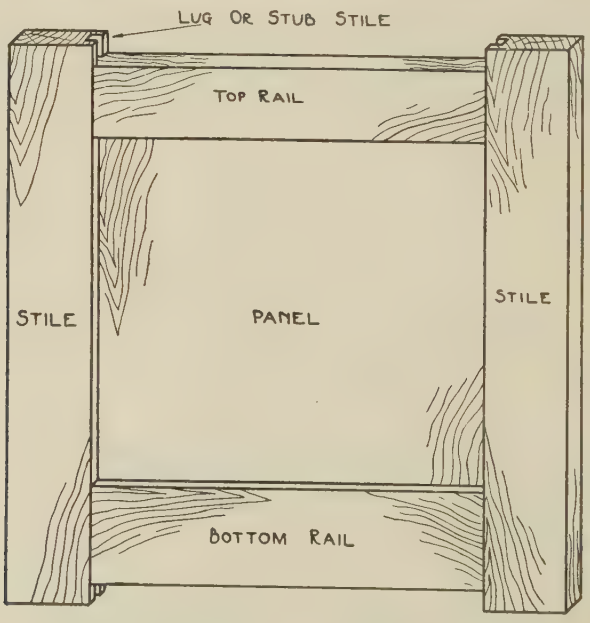


Fig. 358. Parts of a door

the rails at the ends. See Figure 358 for the parts of a door. Mark and saw off the lugs or stub stiles flush (even) with the rails.

2. Fit one edge (the hinge stile)

Plane, or rip and plane, one edge and fit it to the frame. Measure the width of the door and the width of the frame, and plane to remove an equal amount of waste stock from each stile to keep the stiles equal in width. Frames are not always square, and one side may not be straight and true, so hold the edge in place to test for proper fit. The edge of the hinge stile should be square with the face.

3. Fit one end

Plane, or saw and plane, either end and hold the door in place in the frame to test for the final fit of both edge and end. The rails on small cabinet doors are sometimes made equal in width, but usually the rail at the bottom of the door is wider.

4. Fit the remaining edge (the lock stile)

Measure the width of the door frame at the top and at the bottom. Mark the corresponding widths on the door and use a straightedge to line for the width. The door should not fit tightly. Plane the edge, making an allowance for the door to swing free. The usual allowance is 1/16 to 1/8 in. all the way around. Consult the instructor concerning the proper allowance on a particular door since many factors must be taken into consideration. The edge of the lock stile is usually beveled (Fig. 359) toward the back to keep it from binding as the door is opened and closed. This is especially necessary on doors made of thick stock. Hold the door in place in the frame, and test often to secure the proper fit.

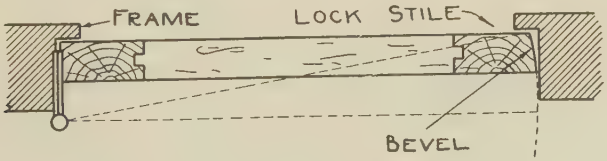


Fig. 359. Enlarged view illustrating the reason for beveling the lock stile of a door

5. Fit the remaining end

Measure the length of the frame, and lay out the measurements on the door. Plane, or saw and plane, to fit the remaining end. Allow clearance for opening and closing.

6. Mark the hinge position

Hold the door in the proper place and, with a knife or narrow chisel,

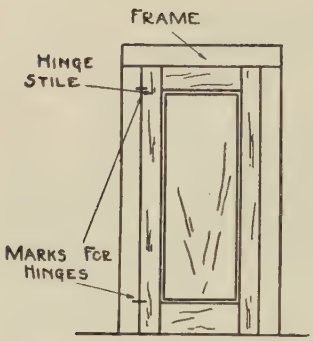


Fig. 360. Mark the hinge position on the stile and frame at the same time

mark on both the hinge stile and frame the exact position of each hinge. (Fig. 360.) The outside ends of the hinges are usually placed in line with the inside edges of the top and bottom rails. On large doors, place a third hinge halfway between.

7. Mark and gain for the hinges

Lay out and gain for butt hinges as in Unit 36. Loose-pin butt hinges (Fig. 361) or tight-pin butt hinges (Fig. 362) usually are used for hanging doors. It is necessary to gain for the leaves of hinges. One leaf

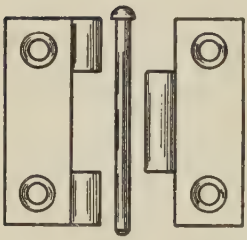


Fig. 361. Loose pin butts as shown above allow the door to be removed by withdrawing the pins

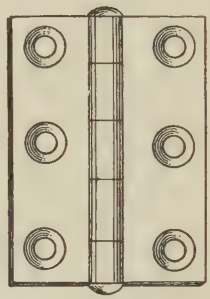


Fig. 362. Tight-pin butt hinge

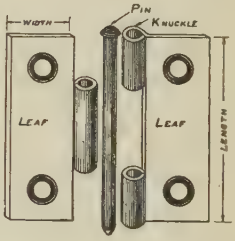


Fig. 363. Parts of a hinge

(Fig. 363) of the hinge is usually gained flush with the door and the other flush with the frame. Sometimes it is necessary to gain in the door for the entire thickness of both leaves. The hinge is placed in position (Fig. 335) to lay out the lines for the length of the gain, and the width and depth are usually laid out with a gauge. (Fig. 337.)

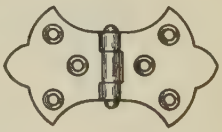


Fig. 364. Surface hinge. Gaining for surface hinges is not necessary

For width, set the gauge to the width of the leaf, or slightly less, according to the clearance desired. For depth, set the gauge equal to the thickness of the leaf. If *surface* hinges (Fig. 364) are used, gaining is not necessary.

8. Set the hinges on the door

Fasten one leaf of each hinge to the door with only one or two flat-

head screws. Set the screws slightly toward the back of the gain in order to pull the hinge tightly into place.

9. Fasten the hinges to the frame

If the butts have loose pins, remove the pins and fasten the other leaf temporarily to the frame with one or two screws. Place the door in position, and insert the pins. If tight-pin butts are used, it is necessary to hold the door in position while the hinge is fastened to the frame.*

Test the door by opening and closing it. If there is a wide opening between the hinge stile and the frame, remove the hinges, and chisel the gains deeper. If the hinge stile binds, and the door will not close because it strikes the frame too soon, the gains are too deep. In this case, put a paper or cardboard (shim) under the hinge. Test again, and when the door fits properly, insert the remaining screws in both door and frame.

10. Attach the lock

See Unit 39.

QUESTIONS:

1. What are butts?
2. Name two types of butts.
3. What is the object of the two types of butts?
4. How is the size of butt hinges indicated?
5. Name the parts of a hinge.
6. What kinds of screws are used to set butts?
7. What is a surface hinge?
8. What is a gain?
9. What is the use of a gain in setting hinges?
10. Name the parts of a door.
11. Name the steps in fitting a door.
12. Should a door fit tightly? Why?
13. How is the lock stile of a door usually planed?
14. What is an average allowance around a door for fitting?
15. Which hinge is often placed farthest from the end in hanging?
16. Are the hinges set on the frame or the door first?
17. Why fasten hinges at first with only one or two screws?
18. What is a "shim" and where is it used?

---

*_Note:_ If surface hinges are to be used, the door is placed in the proper position, the hinge pins are lined up with the joint between the hinge stile of the door and the frame, and then the screws are driven to attach the hinge.

SUGGESTED PROBLEMS:

1. Hang a door with surface hinges. (Fig. 364.)
2. Attach double-acting folding-screen hinges. (Fig. 365.)
3. Attach a lid with chest or box hinges. (Fig. 366.)

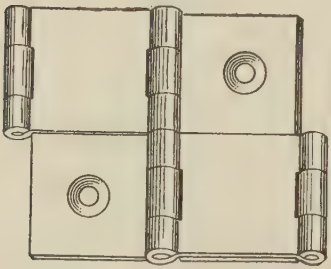


Fig. 365. Double-acting hinge for "folding screens"

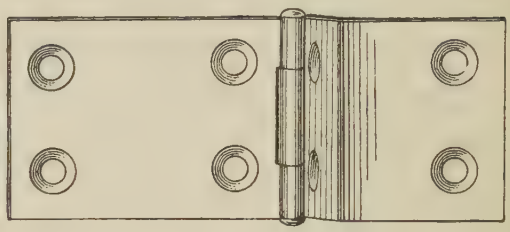


Fig. 366. Chest or box hinge

UNIT 39

TO ATTACH A CABINET LOCK

Cabinets with doors, drawers, or lids often require locks. Many different types of cabinet locks are made. Figure 367 shows the parts of a common cabinet lock. They are furnished as desired with barrel, flat, or corrugated keys. (Fig. 368.) The lock with the corrugated key is the hardest to pick. The general method of attaching cabinet locks is the same.

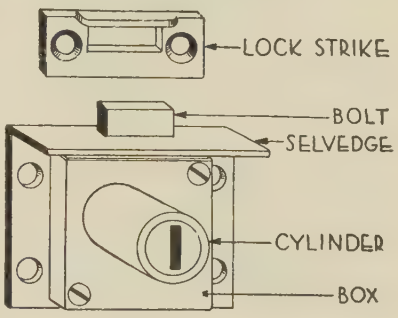


Fig. 367. The parts of a door or drawer lock

Wardrobe locks received their name from their common use on doors and drawers of wardrobes. They can be obtained with the three different types of keys. Figure 369 shows the cylinder type with a flat key, and Figure 370 shows the type with the barrel key. Wardrobe locks are quickly attached since no gaining or mortising is necessary.

Door or *drawer* locks of the type shown in Figure 367 are set flush, or nearly so, with the surface. They are also furnished for the three types of keys. The surface must be gained in order to set the lock flush.

Mortise locks are set in a mortise, as the name implies. (Fig. 371.) They are set so that nothing is visible but the selvage and the keyhole or escutcheon. Such locks usually have a barrel key. Cylinders would have to be removable in order to install such a lock in a mortise.

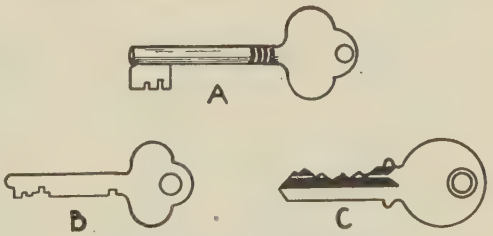


Fig. 368. A, barrel key; B, flat key; C, corrugated key

Chest locks are used on the lids of chests or boxes. The cylinder is the most popular type (Fig. 372), but they are also furnished with the barrel key.

Tools: Rule; knife or pencil; gauge; brace and auger bits; drill and twist bits; keyhole saw; chisel; mallet; depth gauge; screw driver.

Material: Locks; screws to fit.

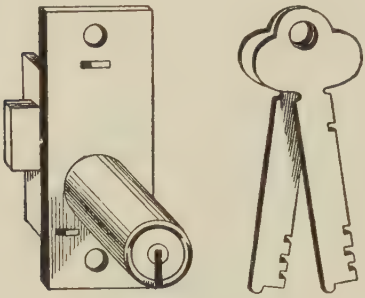


Fig. 369. Wardrobe lock with cylinder and flat key

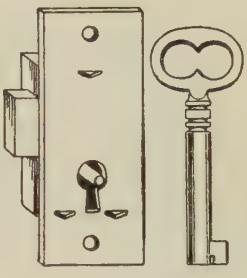


Fig. 370. Wardrobe lock with barrel key

PROCEDURE:

1. Locate the position

Locks on drawers and chests are usually placed in the center. Door locks are placed in the most convenient position for operation. Measure for the center of the keyhole or cylinder on the front of the drawer or door.

2. Bore the hole for the cylinder, or bore and saw for the keyhole

When boring for a cylinder lock, be sure to bore perpendicular to the surface. Figure 373 shows the method of attaching a cylinder wardrobe lock. Where a barrel key is necessary, use small bits and a keyhole saw for the keyhole. (Fig. 172.)

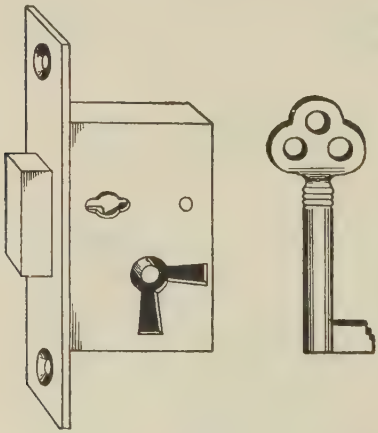


Fig. 371. A mortise lock

3. Cut the gain or mortise (if necessary)

See Unit 36 for directions on gaining, and Unit 37 for mortising.

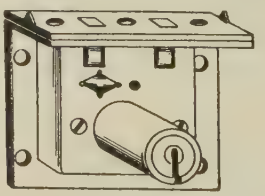


Fig. 372. A chest lock

Wardrobe locks need no gain or mortise. A gain is cut for the locks in Figures 367 and 372. Hold or push the lock into place, and mark for the layout of the cuts. Figure 374 shows the gain for the selvedge and box

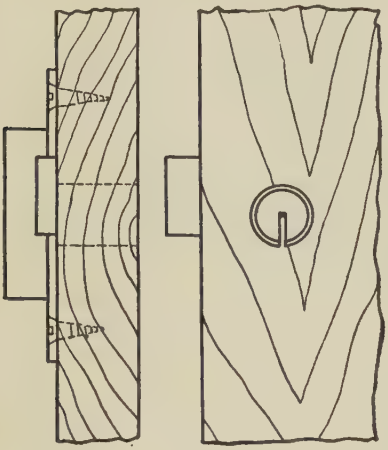


Fig. 373. Method of attaching a cylinder wardrobe lock. Bore hole for the cylinder and attach with screws

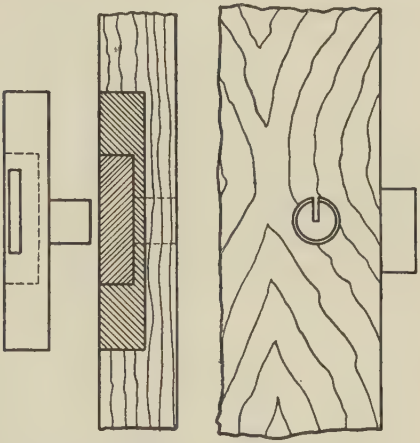


Fig. 374. Method of attaching a door or drawer lock as shown in Figs. 367 and 372. Note that a gain is made for the selvedge and box of the lock

of a door or drawer lock. A mortise is cut for the lock in Figure 371. The method of attaching a mortise lock is shown in Figure 375.

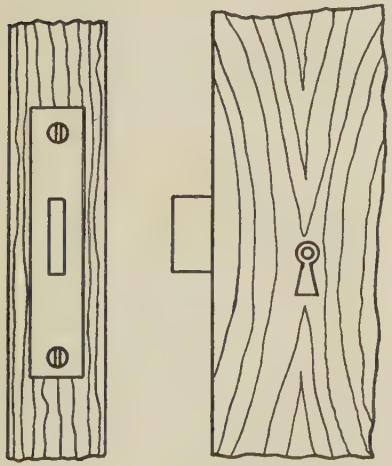


Fig. 375. A mortise lock attached

4. Attach the lock with screws

Use small, flathead, iron or brass screws. Bore carefully for the pilot holes.

5. Attach escutcheon plate (if desired). (See Fig. 376.)

Bare keyholes may be covered with one of the many escutcheons

Fig. 376. Escutcheon plates are used to cover and protect common keyholes

obtainable, or left bare as desired. Cylinder locks need no escutcheon plate.

6. Attach lock strike with screws

When locked, the bolt of the lock catches in the lock strike. Completely attach the lock, and close the door to locate the exact position of the lock strike. The strike is sometimes attached to the frame or to another door. When the lock is attached to one of double doors, the other door contains the lock strike and is usually held closed with an elbow catch. Cut a gain or a mortise according to the type of the strike. In chest locks, the strike is attached to the lid of the chest or box. Lock the strike in the lock, and lower the lid. Strike several blows on the lid above the lock and the spurs on the strike will mark its position. Then attach the strike flush with the surface.

QUESTIONS:

1. Where are the common cabinet locks attached?
2. Name the common types of cabinet locks.
3. Where did wardrobe locks get their name?
4. Why are wardrobe locks used extensively?
5. What types of wardrobe locks are made?
6. What is the advantage of a cylinder lock?
7. What is a barrel-key lock?
8. Why gain or mortise for a lock?
9. Mortise locks are usually of what type? Why?
10. What is the selvedge of a lock?
11. Where are chest locks used?
12. What is an escutcheon plate?
13. When is an escutcheon plate not needed?
14. What is the use of the lock strike?
15. When is the lock strike installed?
16. In chest locks, where is the lock strike placed?
17. In boring for a cylinder lock why should the hole be bored perpendicularly?

INDEX

Adjusting a cabinet scraper, 86
Alphabet of lines, 5
Angles, duplicating, 27; laying out other than 90 degrees, 26
Angle of 30 and 60 degrees, setting by measurement, 27
Angle of 45 degrees, setting by measurement, 27
Animal glue, hot, 136
Assembling, a cabinet scraper, 86; a half-lap joint, 180; a rabbet-and-butt joint, 185; and adjusting a plane, 50, 51, 52, 71

Backsaw, 46; sawing with, 36
Bar clamps, clamping with, 128
Bench rule, 17
Bevel on plane iron, grinding, 59
Beveling an edge, 74
Bill of material, 10, 11, 16
Bit, fastening in the brace, 120; selecting, 118, 125
Blank forms, making out, 11
Blind mortise-and-tenon joint, 202
Blocks, preparing for a clamp, 128
Bookrack, 8
Boring a hole, 120, 126; for an inside curve, 105
Boring, with brace and auger bits, 117; with twist drills or drill points, 123
Box nails, 149
Brace and bit used to remove stock from mortise, 202
Braces or plates used to strengthen or fasten joints, 173
Burnishing the edge of a hand scraper, 88
Butt joint, fastening with dowels, 162; fastening with nails, 148; making and assembling, 148

Cabinet lock, attaching, 215
Cabinet scraper, adjusting, 86; assembling, 86; filing to a keen edge, 85; whetting the edge, 85
Cabinet-scraper blade, burnishing unbeveled side of, 85
Caliper rule, 18
Calipering with a rule, 20
Casein glue, 139
Casing nails, 149
Center line, 5
Chamfer, gauging for, 81
Chamfering:
  end grain, 82
  with the grain, 81
Chest lock, 215
Chisel, grinding, 60; whetting, 61
Chiseling:
  a half-lap joint, 179
  a mortise, 203
Clamps, 129; adjusting, 128; determining the number and position of, 129
Clamping, a double iron in a plane, 54; a joint, 140; a saw, 40; or holding stock, 104; or supporting stock, 68, 106; stock, 72, 77, 127; with bar clamps, 128; with hand screws, 131; with screw clamps, 131
Cleaning an oilstone, 62, 64
Clinching a nail, 154
Combination bench and sawhorse, 12
Common nails, 149
Corrugated fasteners, 150
Cost of stock, approximate, 13
Crosscutting handsaw, 33
Crosscutting saw, 44
Crosscutting to the line, 35
Curved surfaces, shaping, 108
Curves, laying out, 103, 105; paring with a common chisel, 108; paring with a gouge, 111; sawing, 103, 104, 106; shaping with a cabinet file or rasp, 114; shaping with a spokeshave, 111
Cutting:
  a gain or mortise, 216
  a tenon, 205
Cutting edge of plane iron, shaping, 57
Cylinder lock, boring hole for, 216

Dado, chiseling out, 190; cutting out and fitting the joint, 195; laying out, 189, 194; marking location of, 193
Dado-and-butt joint, fastening, 191; making, 188; trial assembly of, 191
Depth adjustment of plane iron, making, 54
Depth of cut, adjusting, 54
Depth of a gain, laying off the, 198
Designs, laying out with a pattern, 97
Dimension, determining, 20
Dimension line, 5
Distances, laying off, where rule must be moved, 20
Dividing a board into parts with a rule, 21
Door, hanging, 210
Door or drawer lock, 215
Double iron, clamping in plane, 54
Dowels, boring holes for, 164; preparing, 165; selecting proper size, 164; used to fasten a butt joint, 162
Drawing the edge of a hand scraper, 88

Edge, beveling, 74; jointing, 72, 143; planing, 71
Edge of plane-iron blade, stropping, 65
Edge to be planed, selecting, 71
Ellipse, laying out, 100
End for end planing, selecting, 76
End grain, chamfering, 82; planing, 76
Escutcheon plate, attaching, 217
Extension or witness line, 5

Face side, marking, 74; planing, 50, 51; selecting and rough planing, 142
Face surface, planing, 66; selecting, 66
Fastening the bit in the brace, 120
Fastening hinges to a frame, 213
Figures and designs, laying out, 97
File, selecting, 42
Filing a cabinet scraper to a keen edge, 85
Finished- and rough-stock lists, 10
Finished-stock list, making out, 13
Finishing nails, 149
Fitting a handsaw, 40
Flat-head nails, 150
Folding rule, 17
Framing square, 23; used to square lines, 25

Gain, laying off the depth of, 198; laying off the length of, 197; laying off the width of, 197; paring, 199; testing, 199; scoring, 198
Gaining for a joint, 196
Gauging, 30; methods used for, 29; for a chamfer, 81; with a marking gauge, 29; with a pencil, 31; with rule and pencil, 31
Glue, animal, 136; applying, 139, 140, 144; casein, 139; common, mixing, and applying, 135; determining amount of, 136, 139; melting, 138; selecting and preparing, 142; selecting grade of, 136; soaking in clean, cold water, 137, 138
Glue and water, mixing, 139; weighing, 139
Glue pot, water-jacketed, 136
Gluing joints, 165
Gluing up stock, 142; face to face, 144
Grinding, a chisel, 60; a plane iron, 56

Half-lap joint, assembling, 180; chiseling, 179; fastening, 181; laying out, 177; making and fastening, 176; sawing shoulders of, 179
Hand ripsaw, selecting, 37
Hand scraper, burnishing the edge of, 88; drawing the edge of, 88; re-forming the edge of, 87; scraping with, 87; scraping a surface with, 89; whetting the edge, 88
Handsaw, fitting, 40; pointing, 47; ripping with, 37; to crosscut with, 33
Hand screws, clamping with, 131
Hanging a door, 210
Haunched mortise-and-tenon joint, 207
Hexagon, laying out, 99
Hinges, fastening to a frame, 213; setting on a door, 212
Hinge position on door, marking, 211
Hinge stile, 211
Hole, boring, 120, 126
Hole, for cylinder lock, boring, 216; for dowels, boring, 164; for shank of screw, drilling, 157; determining size and location of, 123; locating, 120

Inside curve, boring hole for, 105; sawing with a compass saw, 105
Invisible outline, 5
Irregular curves, laying out from drawings, 101
Isometric drawing, 5

Jack plane, selecting, assembling, and adjusting, 68
Joint, clamping, 139, 140; fastening, 195; fastening with screws, 156; gaining for, 196; gluing, 165; making, 162; making trial assembly of, 165; strengthening or fastening with plates or braces, 173
Joint edge, planing, 50, 51
Jointing an edge, 72, 143

Lateral adjustment of plane iron, making, 54
Laying off the width of a gain, 197
Laying out, for crosscutting, 34; a curve, 103, 105; designs with a pattern, 97; for dowels, 163; an ellipse, 100; a half-lap joint, 177; irregular curves from drawings, 101; lines, 23; miter box for the cut, 168; a mortise, 202; the rabbet, 194; a regular hexagon; 99; a regular octagon, 99; a rounded corner, 100; a tenon, 204; various figures and designs, 97
Layout for ripping, 37
Limbering sandpaper, 92
Lines, laying out, 23
Locating a hole, 120
Location of dado, marking, 193
Lock, attaching, 213; attaching with screws, 217; cabinet, 215; chest, 215; door or drawer, 215; locating position of, 216; mortise, 215; wardrobe, 215
Lock stile, 211
Lock strike, attaching with screws, 218
Lumber, figuring cost of, 15
Lumber bill, 11; making out, 15

Mark and gain for hinges, 212
Marking the face side, 74
Marking gauge, parts of, 29; setting, 30
Marking-gauge pin, sharpening and adjusting, 29
Measuring woodwork, 17

Miter, sawing, 169
Miter box, laying out for the cut, 168; selecting or making, 167
Mitered joints, fastening, 171; making and fastening, 167
Mixing and applying common glues, 135
Mortise, chiseling a, 203; cutting, 216; laying out, 202
Mortise-and-tenon joint, blind, 202; fastening, 206; fitting, 205; haunched, 207; making, 201; open, 207; through, 206
Mortise lock, 215

Nail, clinching a, 154; determining direction of driving a, 151; determining number and position of, 151; driving a, 153; selecting kind and size of, 149; starting a, 152; withdrawing a, 154; used to fasten butt joints, 148

Oblique drawing, 5; and orthographic projection, 7
Octagon, laying out, 99
Oil, applying to oilstone, 62
Oilstone, cleaning, 62
Open mortise-and-tenon joint, 207
Orthographic projection, 4; and oblique drawing, 7
Outside curves, sawing with a coping saw, 103; sawing with a turning saw, 105

Paring, curves, with a common chisel, 108; with a gouge, 111; a gain, 199; with a drawknife, 109
Pencil gauging, 31
Pictorial drawing, 5
Pilot hole, drilling, 157
Plane, assembling and adjusting, 50, 51, 52, 71; selecting, assembling, and adjusting, 77
Plane iron, examining, 53; grinding, 56; placing in proper position on the coarse stone, 62; removing, 52; testing for sharpness, 64; whetting, 61; whetting on a coarse stone, 63; whetting on a fine stone, 64
Planing, an edge, 71; an end, 51, 78; end grain, 76; the face side, 50, 51; a face surface, 66; a joint edge, 50, 51; the second edge, 50, 51; the second side, 50, 51; a surface, 68; a through chamfer, 80
Plane-iron cap, fastening to plane iron, 53; used as a guide, 56
Plates or braces, attaching, 175
Plates and braces, different types of, 174; used to strengthen or fasten joints, 173
Pointing a handsaw, 47
Rabbet, cutting out, 184, 194; laying out for the, 183, 194
Rabbet-and-butt joint, assembling, 185; fastening, 185; making, 182, 193
Re-forming the edge of a hand scraper, 87
Removing a plane iron, 52
Reading a working drawing, 4, 7
Ripping layout, 37
Ripping, to the line, 37; with a handsaw, 37
Ripsaw, 42
Rough stock for a project, 1
Rough-stock list, making out, 14
Rounded corner, laying out, 100
Routing order, 1, 50
Rules, graduations on, 18; commonly used in woodwork, 17; used to divide a board into parts, 21

Sanding a surface, 91, 94
Sandpaper, limbering, 92; selecting proper grade of, 91; tearing, 94
Sandpaper block, selecting and fitting, 94
Saw, clamping, 40; crosscutting, 44; side-jointing, 48
Saw cutting edge, top-jointing, 41
Saw teeth, shaping, 42
Sawing, curves, 103, 104, 106; inside curves with a compass saw, 105; a miter, 169; off one end, 51; outside curves with a coping saw, 103; outside curves with a turning saw, 105; the piece to length, 50, 51; shoulders of a half-lap joint, 179; to straight lines, 33; with a backsaw, 36
Scraping a surface, 84; with a hand scraper, 87, 89; with a cabinet scraper, 85
Scoring a gain, 198
Screw, driving a, 160; flat head, countersinking, 158; for fastening joints, diameter and length of, 156; for fastening plates or braces, 175; used to attach locks, 217; used to attach lock strike, 218; used to fasten a joint, 156
Screw clamps, clamping with, 131
Screw driver, selecting, 160
Screw hole, plugging a, 160
Second edge, planing, 50
Second side, planing, 50
Setting a backsaw, 46
Shaping, curved surfaces, 108; saw teeth, 42; curves with a cabinet file or rasp, 114; curves with a spokeshave, 111
Sharpness of plane iron, testing, 64
Short distances, laying off, 19
Shoulders of dado, sawing, 189
Side-jointing a saw, 48
Sliding T-bevel square, 23
Squaring lines, across the edges of a board from the face, 26; across the face of a board with a try-square, 24; with a framing square, 25
Squaring up stock, 50, 177, 183, 189, 193, 202
Stiles, sawing off, 210
Stock, clamping, 72, 77, 127; clamping or holding, 104; clamping or supporting,

68, 106; gluing up, 142; gluing up face to face, 144; heating for gluing, 138; removed from mortise with brace and bit, 202; squaring up, 50, 177, 183, 202; warming for gluing, 143
Stock lists, finished and rough, 10
Stone, cleaning, 64
Stropping the edge of a plane-iron blade, 65
Surface, planing, 68; sanding, 94; scraping, 84
Swing board, 7

Tearing sandpaper, 94
Tenon, cutting, 205; laying out, 204
Testing, a board for warp and wind, 67; a gain, 199
Through chamfer, planing a, 80
Through mortise-and-tenon joint, 206
Tool for holding the bit, selecting, 124
Toolrest, adjusting for 25 to 30 degrees, 58
Top-jointing the cutting edge of a saw, 41
Trial assembly, of dado-and-butt joint, 191; of pieces of stock, 143
Try-square, 23; used to square a line across the face of a board, 24
Twist drills or drill points, boring with, 123

Unfinished surface, sanding, 91
Visible outline, 5
Wardrobe lock, 215
Warp and wind in board, testing for, 67
Water-jacketed glue pot, 136
Whetting, the edge of a cabinet scraper, 85; the edge of a hand scraper, 88; a plane iron, chisel, etc., 61; a plane iron on a coarse stone, 63; a plane iron on a fine stone, 64
Wire brads, 149
Woodwork, measuring, 17
Woodworking squares, 24
Working drawing, reading a, 4, 7; of a wren house, 2
Wren-house working drawing, 2

Zigzag rule, 17

376-AAY-001